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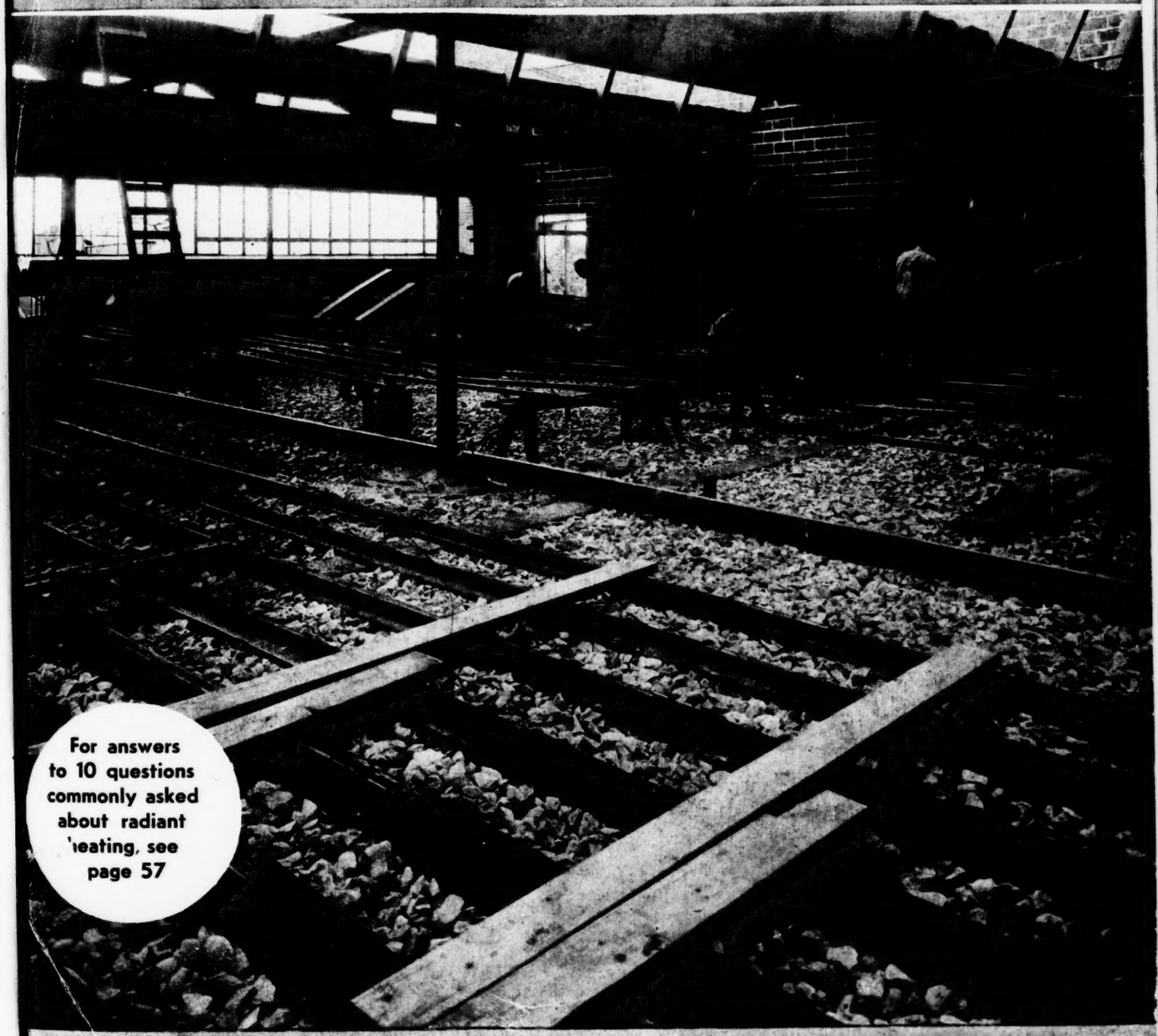


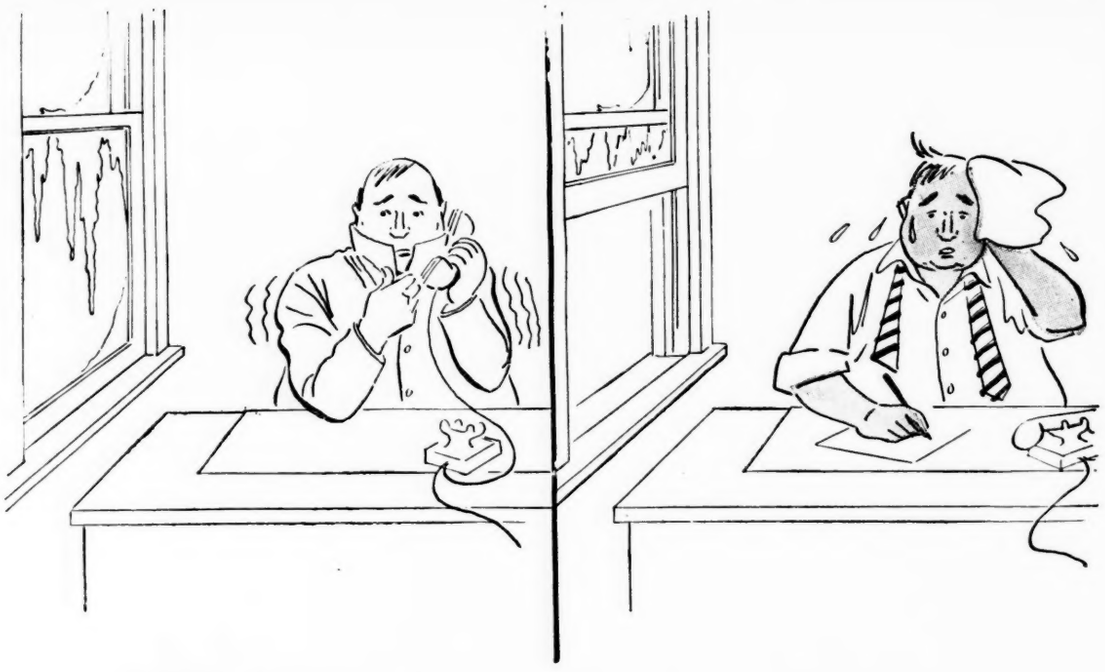
For answers to 10 questions commonly asked about radiant heating, see page 57

Electrothermal Space Heating and Air Conditioning . . page 67

Gasoline Piping Design and Storage Problems page 51

Atmospheric Pollution Due to Gas . . page 64

Refrigeration Drafting Symbols page 61



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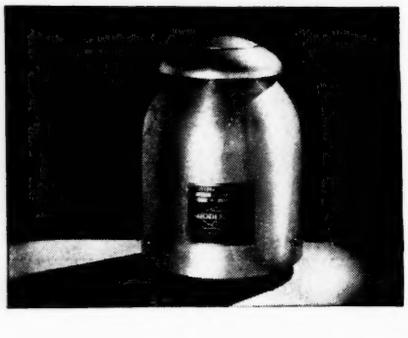

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VENTILATING

A MONTHLY MAGAZINE FOR ENGINEERS AND CONTRACTORS CONCERNED WITH COMMERCIAL, INDUSTRIAL AND INSTITUTIONAL AIR CONDITIONING, REFRIGERATION, AIR SANITATION, PIPING, HEATING AND VENTILATION

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CONTENTS FOR JANUARY, 1945

VOLUME 42 NUMBER 1

Gasoline Piping and Storage 51
Harry D. Unwin

Anzio Refrigerating Plant Operated Under Fire 56

Answers to Radiant Heating Questions 57
Elmo Hall

Norden Bombsights Have Heated Covers 60

Refrigeration Drafting Symbols 61
Nathan N. Wolpert

Ventilating a Tunnel During its Construction 63

Atmospheric Pollution Due to Gas 64
Arthur C. Stern

Blueprint of Post-War Realities—Electrothermal Space Heating and Air Conditioning 67
George H. Krueger

Transport Converted Into Hospital Ship 79
F. N. Hollingsworth

Central Heat for Iceland 84

Zoning of Heating Systems for Post-War Comfort and Fuel Economy 85
T. W. Reynolds

Reference Data 285-286 86

Heat Transfer Film Coefficient for Ammonia 87
B. F. Raber and F. W. Hutchinson

Washington News 91
Loring F. Overman

Reviews of Technical Publications 92

News of the Month 94

Degree-Days for November, 1944 98

News of Equipment and Materials 102

Getting Personal 108

New Catalogs 109

Since the Last Issue 111

Coming Events 115

Industrial Degree-Days for November, 1944 116

Canadian Degree-Days for November, 1944 116

Army-Navy "E" Awards 117

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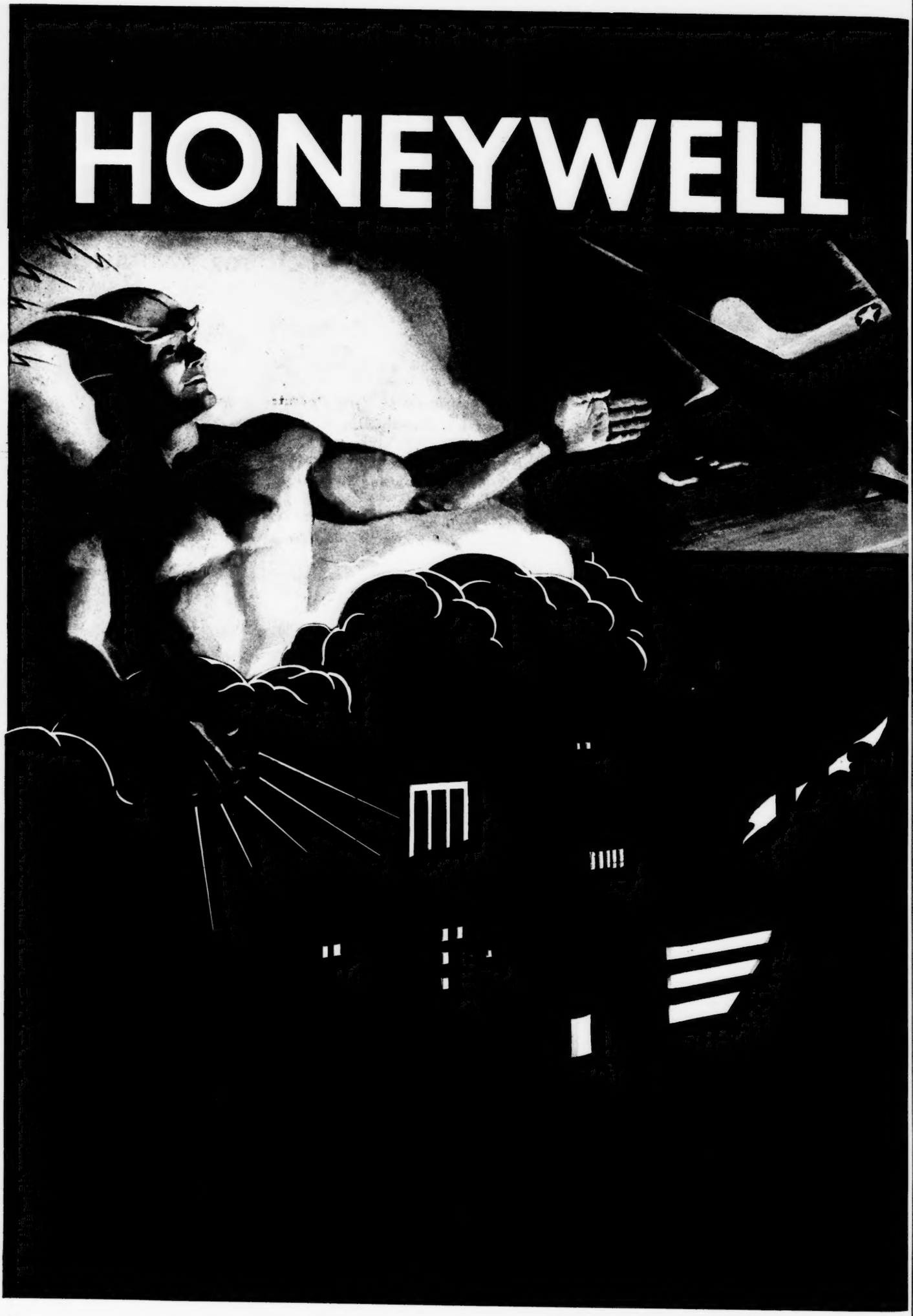
NEXT MONTH'S ISSUE

Practical pointers on operation of dust collecting systems, blowers, exhausters, and duct work will be presented as a special section. Essentially it is information that an engineer engaged in that work has collected in the field over a period of years.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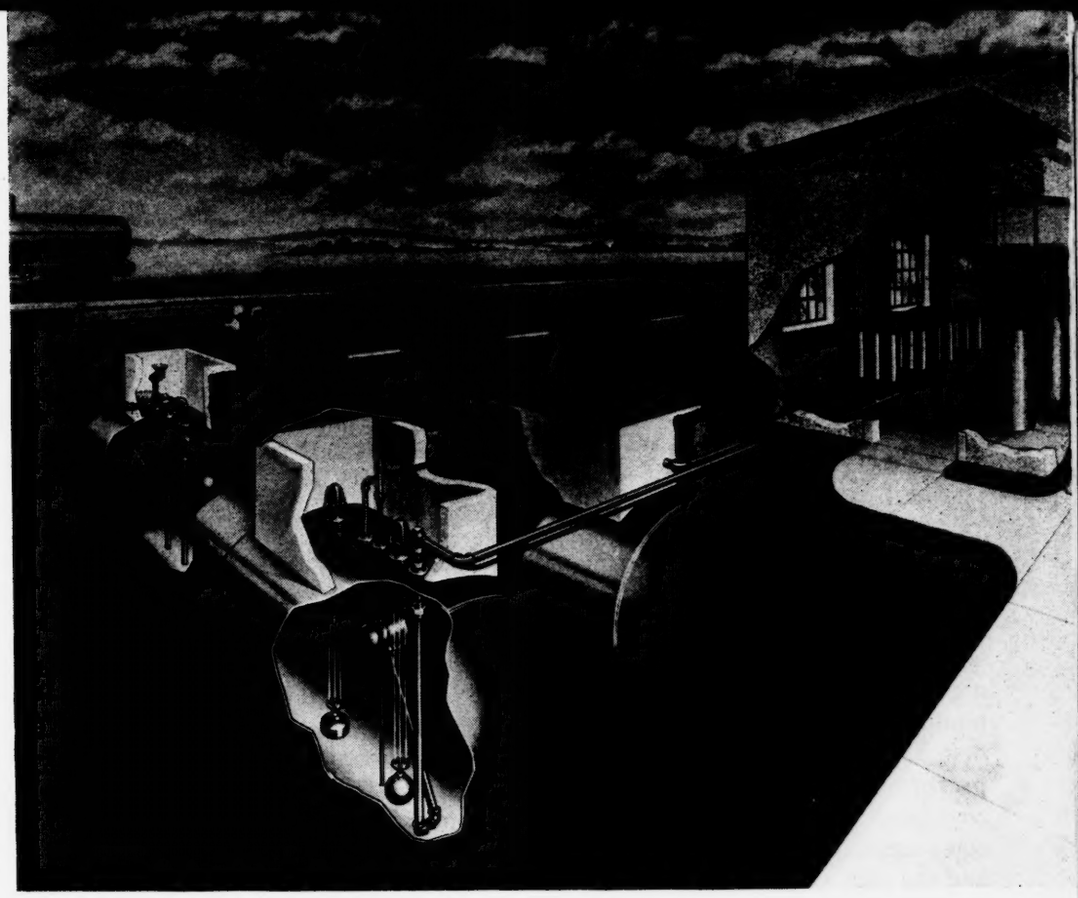


Fig. 1. A below-ground multiple storage system with rotary pumps for isolated location.

Gasoline Piping and Storage

HARRY D. UNWIN
Mechanical Engineer, Albert Kahn Associated Architects and Engineers, Inc.

The volatile nature of gasoline gives rise to numerous problems both in storage and distribution not encountered with some of the more easily handled fluids. In this first installment of a series of articles on gasoline, the author discusses storage facilities and some of the types of distribution systems. Subsequent installments will cover other types of distribution, design of piping, and system safeguards. This series is the third on Process Piping in Industrial Plants, gas piping having been treated in the July and August, 1944, issues, and oil piping in September, October, and November, 1944, issues.

THE design of gasoline handling systems is sharply contrasted to the requirements for fuel oil and other viscous liquids. By definition, gasoline is a refined petroleum naphtha which by its composition is suitable for use as a carburant in internal combustion engines (A.S.T.M. designation D 288-39). From so broad a definition, it is apparent that gasoline may consist of a single component or a combination of a wide range of constituents; and since it is to be used as a carburant, gasoline must volatilize readily. This, probably more than any other characteristic, determines the nature of storage and pumping facilities to be installed in the handling system and gives rise to a number of problems not heretofore considered in relation to process piping in industrial plants.

Except for natural gasoline (casinghead gasoline), all commercial grades of gasoline are blends of various manufactured components, each of which has its own definite vapor pressure. This property determines pump design and must always be considered in regard to storage tank location and the design of pump suction conditions. The accepted method of determining the vapor pressure is by means of the Reid method (A.S.T.M. designation D 323-42) which consists of obtaining the pressure of the vapor in equilibrium with a given quantity of liquid in a chamber of standard dimensions at 100F. However, since each component of the commercial grades of gasoline has its individual Reid vapor pressure rating, not all products of the same grade will have the same vapor pressure. For example, gasoline blends may consist of two or more of the following pure compounds:—

Part of a Series of Articles on Process Piping in Industrial Work

Blending Component	Reid Vapor Pressure, Lb per Sq In
Isopentane	21.0
Neohexane	6.0
Isooctane	1.5
Benzene	3.2
Aviation naphtha	3.5
Others	2.5

It is seen that a blend could be made with varying percentages of such components and as a result the vapor pressure would also vary. For this reason the maximum vapor pressure for aviation grade gasoline has been standardized at a maximum of 7.0 lb per sq in., absolute, and for automotive grade at 9.5 to 13.5 lb per sq in., absolute, depending upon the season of the year and territorial location.

Since gasolines are rated on their anti-knock values or octane numbers such as 45, 65, 73, 91 and 100 octanes, it would be of considerable value in determining pump suction conditions if there existed a definite relationship between octane rating and vapor pressure. This could be readily done if the standards covered definite and fixed percentages of blending components. Because of the various refining processes and the wide range of hydrocarbon compounds which constitute the gasoline blending components it is impractical to assign fixed ratios for these components, hence the vapor pressures of the resulting blends will always differ.

From the above partial list of blending components it is apparent that each of the materials, or combinations of them, could be used for aviation gasoline except isopentane which could be used only in small percentages in order to maintain a maximum vapor pressure of 7.0 lb. Therefore, due to the large variation in the combinations of base stocks which can be used to manufacture aviation gasoline, it is practically impossible to design distribution systems on the basis of actual vapor pressure specifications so that the use of the maximum permissible Reid vapor pressure of 7.0 lb absolute is warranted and is on the side of safety. However, according to the A.S.T.M. specification for the determination of this vapor pressure, the ratio of the volume of the air chamber to the volume of the gasoline chamber shall be between the limits of 3.8 and 4.2. This raises the question as to the value that can be attached to the Reid vapor pressure rating in designing pump suction limitations, since the volumes in the suction passages of impellers are quite small. For this reason, the "bubble point" or "initial boiling point" of the gasoline should be taken into consideration. It is an accepted fact that the vapor pressure is a function of the ratio of components in a blend where all components do not have the same vapor pressure in their pure state. The "bubble point" may therefore be defined as the pressure at which the liquid is in equilibrium with an infinitesimal amount of vapor.

The effect of this basic relationship becomes an important factor in the design of below ground storage systems. It should be noted that while the Reid vapor pressure is at 100F, the temperatures to be found in underground storage tanks is much less and in the neighborhood of 60-70F in the summertime—at which temperature the vapor pressure of 100 octane gasoline may be 5 lb absolute. If the corresponding bubble point is 9 lb, then the permissible suction lift including friction loss is approximately 11.0 feet as illustrated by the following example in which the gasoline has a specific gravity of 0.7 and is stored at an elevation of sea level:—

Atmospheric pressure of gasoline = (14.7 × 2.31) ÷ 0.7 = **48.7 ft.**
Vapor pressure of gasoline = (9.0 × 2.31) ÷ 0.7 = **29.7 ft.**
Available suction lift of gasoline = **19.0 ft.**

However, since approximately 8 feet must be allowed for the proper operation of the pump (this has been proven by many tests), the net permissible suction lift is 19.0 — 8.0 = 11.0 feet of gasoline. At other altitudes and temperatures the suction lift will vary. Experience has shown that a suction lift of 10 to 12 feet, equivalent to approximately 6 to 7.5 inches of mercury, is good design practice.

Storage Facilities

In the selection of the type of storage tank and its proper location carefulness is necessary because of the inflammable nature of gasoline. Consideration must also be given to the quantity to be handled, the grade of gasoline and its purpose in the scheme of operations. If the storage facilities are in connection with an aviation engine plant a considerable quantity will probably be involved, hence the "tank farm" should be located at a safe distance from manufacturing buildings. Installation of storage facilities for an airport, garage, or service station will depend upon other factors and special conditions which will be discussed later. Neither storage nor distribution of inflammable liquids can be segregated in determining the proper system for a particular installation. Each is dependent upon the other to the extent that it is a fallacy to speak of the cost per gallon of storing the products since the type of distribution may produce an over-all economical "handling" cost not reflected in the prorated per gallon storage cost; therefore, we shall first explore the several types of storage containers and then describe the different methods of delivering the gasoline to the points of consumption.

Gasoline refineries and bulk transfer stations, almost without exception, store volatile liquids in above ground steel tanks of which there are several types depending upon the service for which they are intended, and such as, (1) atmospheric or vented tanks, (2) tanks with variable volume vapor spaces, (3) tanks with floating roof decks, (4) pressure tanks, and (5) concrete tanks. All of these types of containers, except the concrete design, are of either welded or riveted steel plate construction. Vented steel tanks, pressure tanks and tanks of concrete construction may be erected either above or below ground depending upon local conditions.

In the storage of gasoline and other volatile liquids, in tanks vented to the atmosphere, vaporization losses occur due to tank breathing and as the result of the filling and emptying of the containers which under certain conditions may be of considerable magnitude. Such losses are a function of the volatility of the liquid, variations in atmospheric temperature, dimensions and volume of the tank vapor space, and type and color of paint covering the external surface of the tank. The so-called filling loss occurs as a result of the vapors in the space between the liquid and tank roof being expelled during the refilling of the storage tank. It is apparent from the foregoing discussion that these vapors which constitute the air-vapor mixture are directly related to the Reid vapor pressure of the liquid. This loss is of little consequence when the storage tanks are emptied only a few times a year, but when the cycle is accelerated the loss may be considerable. In passing, it is well to mention that there are various vent caps on the market which are designed to reduce this loss by controlling the pressure at which venting occurs, which materially reduces the amount of loss over the wide open type of atmospheric vent. Another means tending to reduce this vaporization loss is to refill the storage tank at a rapid rate to reduce the surface evaporation.

Floating Roof Deck

To overcome the loss due to evaporation when the liquid level is lowered in vertical steel tanks the floating roof deck was designed. Originally, this consisted of a single thickness roof floating on the liquid and changing its position with the liquid level in the storage tank. However, it was found that the temperature of the liquid surface was materially increased as a result of the heat imparted to the metal by the sun and this raised the temperature to such an extent that the vapor pressure was raised causing increased venting losses. To overcome this objection, the pontoon type floating deck was designed which consisted of segmental chambers about 12 to 18 in. deep. Although the top of the roof was at the same temperature as the single deck roof, the air space within the pontoons effectively insulated the gasoline surface and materially reduced the evaporation loss. The floating roof type of construction has the advantages of reducing filling losses and decreasing fire hazards. The rate of evaporation depends largely upon the vapor pressure of the gasoline and the construction of the seals between the pontoon deck and the tank periphery.

Storage of inflammable liquids under pressure is possible by increasing the pressure in the storage container to a point slightly above the vapor pressure of the liquid. In this case, the vapor loss from high volatile liquids is almost negligible. It is customary to induce this excess pressure by means of an inert gas. Compressed air should never be used because of the hazard of producing an inflammable air-vapor mixture.

Another method of overcoming the vapor loss is through the use of the so-called hydraulic tank which is not vented and does not truthfully fall under the classification of pressure containers, although it is used in conjunction with hydraulic pressure distribution systems, and the containers are constructed in accordance with the A.S.M.E. Code for Unfired Pressure Vessels rather than the National Board of Fire Underwriters' requirements. Since water is used as the motive force to deliver the product to points of use the tank contains both gasoline and water and is therefore continuously full, thus eliminating the vapor space.

Concrete Storage Tanks

Concrete storage tanks have long been used to store water and viscous liquids, but it took the necessities of war and the need to conserve critical materials to adapt them to the storage of gasoline and volatile liquids. It is well-known that reinforced concrete shrinks in setting, resulting in compressive stresses being set up in the steel. Since steel rods are normally used to carry tensile stresses the setting up of the concrete causes a reversal of the stresses and results in considerable deflection of the steel and cracks in the concrete. The Bureau of Yards and Docks, Navy Department, has adopted a design of circular reinforced concrete tank utilizing a series of "tie rods" for reinforcing which are pulled tight by means of turnbuckles inducing an initial tensile stress in the steel bars and placing the concrete in compression so that this stress relationship will be retained after the setting of the concrete. This type of construction was probably suggested by the similar design used for vertical wood tanks where steel rods pulled tight by turnbuckles hold the lagging in place, except that in the case of the concrete tank the pre-stressed bars are encased in concrete.

Although this type of construction results in minimizing setting cracks the porous nature of concrete demands some sort of treatment of the interior tank walls and floor to prevent penetration of the liquid into the concrete which is particularly important when the liquid is aviation gasoline containing components of toluene, xylene, benzol and other additives that tend to react with the free alkali present in the concrete. Any such reaction will have a detrimental effect upon the quality of the gasoline and must therefore be avoided. During the war period, the need for gasoline storage facilities has been great and of equal importance to the necessity of substituting non-critical materials where possible. Much research and study has consequently been given to the development of materials suitable for lining concrete reservoirs so that new steel storage facilities could be avoided. Although there are many materials resistant to water and gasoline, the addition of aromatic compounds to present-day high-test aviation gasoline has definitely complicated the problem of obtaining suitable linings. Synthetic resins and organic polysulfide films which are applied by

spray or prefabricated sheets have been used, but due to the fact that the latter are a form of synthetic rubber, their use has been restricted.

Any of the above described storage tanks may be used in industrial or commercial installations, but they are more likely to be found where huge quantities of a single grade of gasoline are to be stored such as refineries, along docks and at remote aircraft fueling bases. In aviation engine plants and to some extent in airport installations several grades of gasoline are required. For this reason, small steel tanks of 15,000 to 25,000 gallon capacity each are used. During the war period, the majority of such installations have been made below ground because of the hazard involved if sabotage was attempted and also because the gasoline was maintained at a more constant temperature which lessened evaporation loss and at the same time permitted the fuel to be delivered to the test cells ready for use without excessive temperature control. Practically all aviation engine plants use 65, 91 and 100 octane grades or other grades having similar octane ratings for testing. In some cases, a fourth grade is used and is known as the "Reference Fuel."

To maintain production and guard against possible interruption as well as to provide for fluctuating demands of the various grades of gasoline used it has been found highly advantageous to manifold all the storage tanks so that each can be used in case of necessity for any one of the several grades of fuel employed. In a tank farm of twenty or more tanks storing a total of 500,000 gallons or more, this becomes a problem requiring careful consideration before final selection of the site for the tank farm and type of distribution system are made. Such interconnection is usually made within the pump house so that full control can be obtained without the necessity of operating valves at individual tanks. It has the advantage of confining the complete operation and control of the distributing system within a small area, which makes for more efficient use of the operator's time as well as improving the working conditions and increasing the safety of the total installation.

Distribution Systems

There are two major methods of delivering gasoline from storage to the points of consumption; (1) pumping and (2) hydraulically. Pumping systems may be classified according to the type of pumps used, such as positive displacement, centrifugal and submerged centrifugal or deep-well type of pumps. Positive displacement pumps may be further subdivided into reciprocating and rotary types. Since reciprocating pumps are seldom used in present-day applications, they will be excluded from further consideration. Each of the systems to be described may under certain conditions be employed for industrial plants, airports or bulk transfer stations. Since these systems vary only in the method of storage and distribution it will suffice to merely point out that the filling of the storage tanks from tank cars or trucks is accomplished by either gravity flow or through unloading pumps. In very small installations, use of gravity flow is more economical where there is sufficient difference in elevation to create a pressure head to overcome pipe friction and induce a velocity of flow that will result in a reasonable time of unloading. However, this method is not approved by the National Board of Fire Underwriters or other insurance organizations because of the extreme hazard involved if the unloading connection is broken permitting the flooding of the adjacent area with inflammable liquid. Under certain conditions exceptions are made as for the unloading from tank trucks and extremely isolated tank car unloading stations.

Unloading by pumping is always provided in large installations because of the reduction in unloading time per car and the greater safety that results. During the war years when tank car and truck deliveries have been limited, the delay occasioned by keeping a car at a plant longer than one switching period has been considered wasteful; hence 150 to 200 g.p.m. pumps have been installed so that even with the necessity of unloading a series of several cars simultaneously they could be released at the earliest possible moment.

Although above ground storage tanks may be used, it has been customary in the past few years to install underground tanks for reasons aforementioned. Because of this practice which is good engineering even in peacetime, the following systems will be outlined with this in mind.

Rotary Pump System. Fig. 1 illustrates a below-ground multiple storage system with rotary positive displacement delivery pumps for an isolated location. Tank car unloading is by gravity because of the remote location of the system as might occur at an airport site; also the system is for a single product since all tanks are connected to a common unloading line. At the filling end of the tanks are located the liquid level gauge, stick gauge connection and high level float controlled shut-off valve. At the discharge end of the tank can be seen the floats for low level gasoline and water level control for shutting down the pump. Since water in the form of moisture in the air entering the tank through the vent during draw-down periods will accumulate in the bottom of the tank, provision should be made to prevent any water from getting into the delivery system. A manual pump-out connection for the removal of this accumulated water is always installed. Oftentimes a floating suction is also installed so that the gasoline is always taken from the liquid level. As a third means of safeguarding the system and insuring water-free gasoline, delivery filters of various types are installed on the pump discharge. Air release tanks are shown in the pump house, but these are not essential unless meters are also provided.

There are many variations of the underground storage system some of which materially simplify and broaden its usefulness over the arrangement

shown. Good practice indicates that underground vented tanks should be installed on concrete foundations and securely anchored down whenever there exists excessive ground water, as it is quite common to find this water pressure exerting sufficient force to raise or "float" the tanks to grade level when they are less than full. Even the concrete manheads illustrated would be inadequate to offset this upward pressure. Under certain soil conditions concrete mats covering the entire tank farm have been required and even piling has been used to provide a firm foundation on which to anchor the tanks.

Pumps

In this type of installation, particularly for an industrial application where several grades of gasoline are handled, it has been customary to provide duplicate pumps for each grade and to manifold the tank suction lines of all tanks assigned to store a particular grade of gasoline. However, as a wartime expedient to conserve critical materials only single product pumps have been installed with their suction and discharge connections manifolded so that in an emergency any pump could be used temporarily for any product. This requires a large number of valves or lubricated plug cocks which introduce additional frictional resistance and increases the suction lift. As has been already pointed out, there are definite limitations to the permissible suction lift. If the pumps are located in a house at grade level, the pump suction inlet will probably be about 12 in. above grade. Assuming a storage tank of 8 feet diameter and the usual 3 feet of earth coverage the total vertical lift will be 12 feet which is the upper limit for aviation gasoline without any allowance for pipe friction and loss through valves and strainers. The assumed diameter of 8 feet is rather small for tank capacities over 12,000 gallons; and since it is more economical to install tanks having 25,000 gallons and higher capacity each, the suction lift becomes more out of line. In such a case the only alternative is to lower the pump room floor until the suction lift has been brought within the allowable range.

By providing the pump house with a first floor and basement, the unloading pumps, meters and air release tanks can be located on the first floor; and the delivery pumps with meters, air release tanks and filters installed in the basement. Check valves or foot valves are extremely necessary in such an arrangement where the pump suction is taken through the top of the storage tank.

Everyone knows that water in gasoline is detrimental to proper carburetion, and in sufficient quantities water can cause complete stalling of the engine —a troublesome occurrence in an automobile, but a very serious matter in aircraft engines. Every precaution should therefore be taken to insure water-free gasoline in engine test cells and for airport fueling systems. Probably the least expensive solution is to provide a sump in the bottom of the storage tank to collect the water through gravity separation.

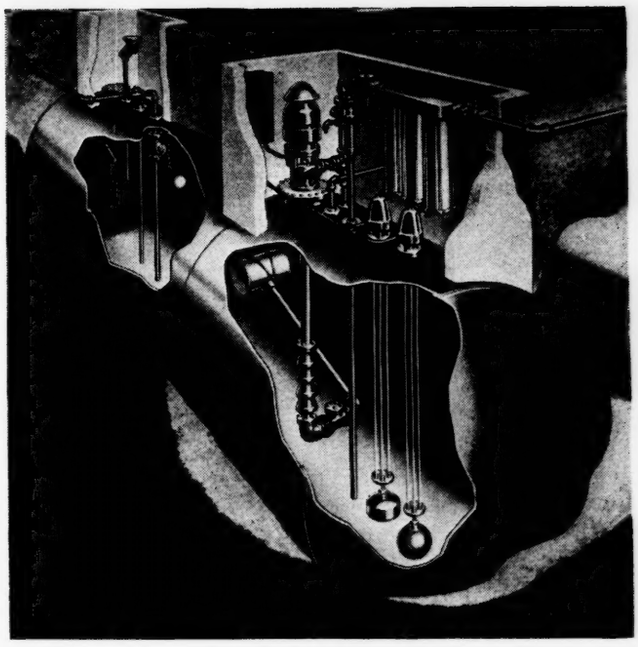


Fig. 2. Submerged centrifugal or deep well turbine type pump.

This requires constant supervision and checking by the tank farm operators so that the accumulation may be pumped out before the level has reached the pump suction. A safer and automatic method is to provide a float on the suction pipe which will sink in gasoline and float in water and which is connected to the delivery pump motor circuit. In the event that accumulation of water reaches the danger level, the power circuit is interrupted, preventing further discharge from the tank. To eliminate the inherent disadvantages of the float control, the electronic method of liquid level control is increasing in favor. Since water is a conductor of electricity and gasoline is not, an electrode is used which completes a circuit when it comes in contact with the rising water level and operates a warning signal or controls a relay to open the pump motor circuit.

Accessory equipment which may be installed to increase the operating efficiency of the system includes liquid level gauges of either the direct reading or remote control type; fill pipe float control to shut off the unloading pump when the storage tank is full; centrifugal filters on the delivery pump discharge as a safeguard against failure of water level float control; a low level cut off and indicator that the tank should be refilled; and a floating suction to insure that the gasoline is always taken from the gasoline liquid level. Use of meters is a refinement that is not always justified since the storage tanks can be measured by stick gauge and the quantity determined by the use of accurate gauging charts. On the other hand, they serve as a useful check on invoices when placed in the unloading line, and when used in the delivery system they offer a means of determining departmental consumption. In airport fueling systems they are an essential item as the distribution is to planes for which consumption or sales records must be maintained. Air release tanks

are necessary in connection with all meter installations to remove entrained air. This air which enters the system when tank cars are unloaded or through suction line leakage will materially affect the accuracy of the meter readings if not removed.

The rotary positive displacement pump system has the advantage of relatively constant discharge, will operate where suction lift is required and is probably best suited for industrial installations where demands are not excessive. This type of pump has the disadvantage that a by-pass is required to return to the storage tank or suction side of the pump the excess liquid when the system demand is less than the pump capacity. For this reason the power consumption during "no demand" and "pump capacity demand" are practically the same. By electrically controlling the running of the pump from remote draw-off stations, the effect of this factor is reduced. The standard automotive service station gasoline dispensing pump is an example of such controlled operation.

Centrifugal Pump System. For the below-ground storage system with centrifugal delivery pumps the foregoing description of storage tanks and controls for the Rotary Pump System is also applicable. The main difference lies in the location of the pumps. Since the characteristics of the centrifugal pump design does not permit the creation of sufficient vacuum in the suction line when handling volatile liquids, it is necessary to locate the pumps below the level of the storage tanks and have the tank suction connection at the bottom to allow for gravity flow to the pumps in order to maintain a flooded suction condition. The pump house basement must therefore be at a lower elevation than for rotary pumps for underground storage. Under certain soil conditions this is a distinct disadvantage. However, when the system demand is large and the difference between maximum and minimum requirements is considerable the centrifugal pump has the advantage because the horsepower to operate the pump is proportional to the quantity being discharged. In large distribution systems, where the pumps must run almost continuously, considerable saving in power is obtained with this type of system. Considerable static electricity may be generated due to the high speed of this type of pump and the excessive turbulence created by the discharge of the liquid against the pump casing as a result of the centrifugal force imparted to it by the impeller. Proper grounding will safeguard this type of installation.

Submerged Pump System. Fig. 2 illustrates the application of the submerged centrifugal or deep-well turbine type of pump. Although the float controls, gauges, pump-out and float suction are provided in a similar manner to the other systems, two very distinct differences exist: (1) The pump passages have very little clearance as compared to the "external" centrifugal pump and the developed head is created through a series of turbine bowls each of which adds its impulse to the liquid received from the previous stage; (2) When used to pump gasoline, particularly high octane aviation gasoline, it has been found desirable to install a by-pass on the discharge to return the excess flow to the tank under low load conditions and thereby reduce the turbulence caused by the rotation of the turbines in the bowls.

This type of system eliminates a separate pump house by subdividing it in the several tank manheads which is a disadvantage when several grades of gasoline are handled and the consumption is large, as the operator must cover more territory and, in addition, maintenance of equipment is more difficult due to being confined within the tank manhead pit. Also starting equipment must be explosion-proof which is not necessary in a pump house as a separate room can usually be provided for them in which case only the push button stations need to be explosion-proof. However, for some installations the submerged centrifugal pump for gasoline systems is increasing in popularity and definitely has its place among the older and better-known methods of distribution. The paramount advantage of this pumping unit is the fact that no limits are placed upon the diameter of storage tanks since the suction inlet is located at the lowest level at which gasoline is to be maintained in the tank.

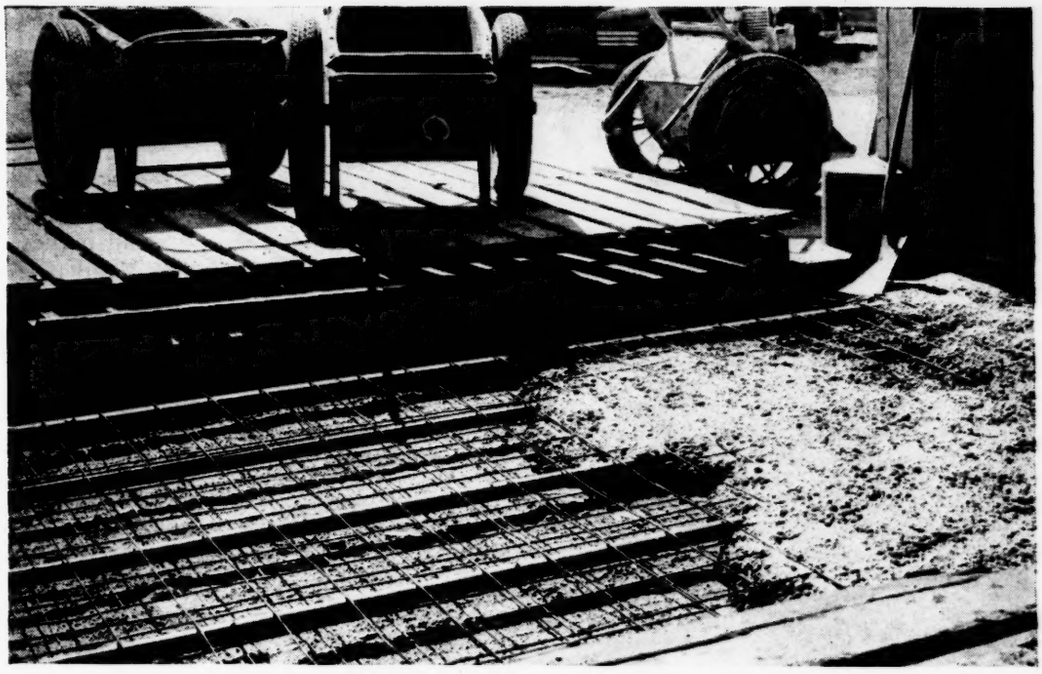
In the next installment Mr. Unwin will discuss hydraulic delivery system, unloading pump house and tank loading system.

Anzio Refrigerating Plant Operated Under Fire

Quartermaster Corps soldiers provided Anzio hospitals with ice and cold storage for food and medical supplies while the troops were pinned to the small Anzio area by enemy fire.

Lack of cargo space as well as the time element prevented the bringing in of ice by ship from the base section and ice was badly needed by the hospitals. The problem was solved when Fifth Army Quartermasters obtained three one-ton portable ice plants and sufficient material for a cold storage room. A group of Engineers pitched in to help with the construction.

Since even the hospital area was subject to constant enemy bombing and artillery fire, the installation was built partially underground. A large excavation was made in which the ice-makers and storage room were set up. The portions extending above ground were surrounded by a thick, sandbag wall so that only a direct hit would seriously damage the plant.



Radiant heating system being installed in the floor of a large garage. Wire mesh reinforcement is placed over the pipe.

Answers to Radiant Heating Questions

as asked during the past two years

ELMO HALL

Consulting Engineer, Denver, Colo.

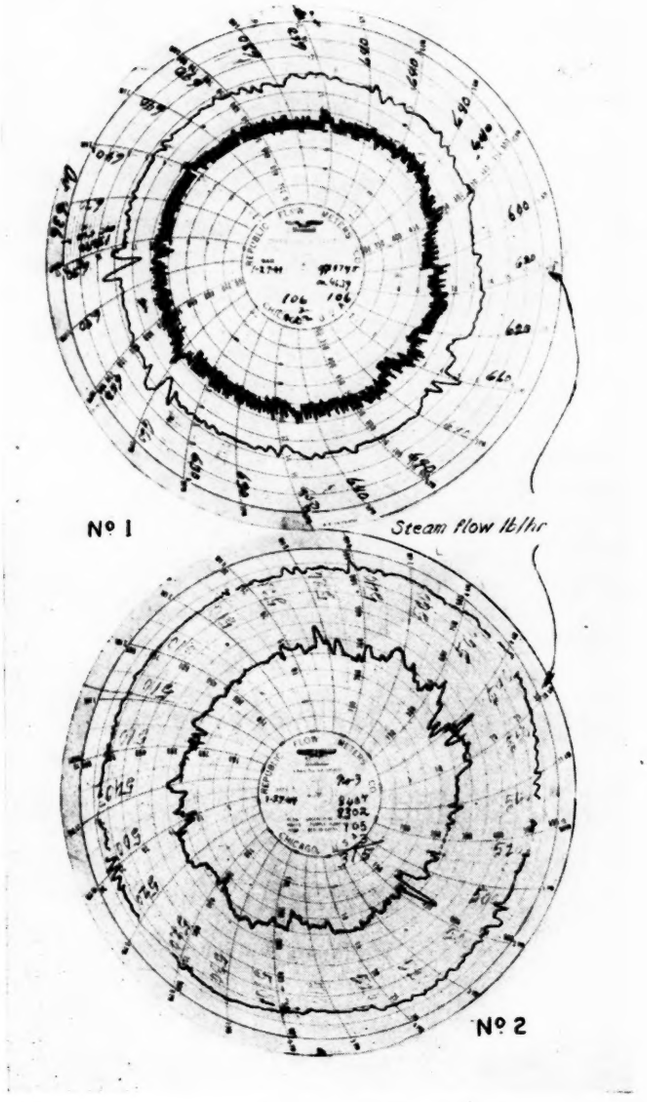
SINCE the appearance of an article on radiant heat in airplane hangars in the September, 1943, issue of HEATING AND VENTILATING, inquiries were received from engineers and architects asking innumerable questions regarding design and operation. The author has selected the ten questions most frequently asked and presents data gathered from two years' experience with the installation mentioned in the 1943 article.

1. Does a radiant heating installation require the same size boiler as a conventional convection installation?

In the case of the hangar installation referred to the boiler size was selected on the same basis as would have been the case if the system were of the usual convection type. Three water tube boilers in battery and of 259 hp each were installed with settings designed for 200% operation against a calculated load of 1140 hp plus occasional use for quickly heating up large quantities of road oil stored in nearby tanks. Actually, the selection of boilers was limited to those used boilers available, as time did not permit waiting for the fabrication of new equipment.

In operation, the highest flow rate as shown on the steam chart for the radiant heating installation, disregarding the high steam rate of the occasional oil heating, has been 580 hp On page 58 is steam chart No. 1 for a 24-hour period during which the maximum temperature was 34F and the minimum 10F. The heating panels in this installation are supplied with hot water through 8 steam heat exchangers each of 5000 gph capacity and the chart clearly indicates the cycles. When steam was supplied to the exchangers, a fairly even average consumption was produced over the period in fluctuations of 2000 lb per hour due to the off and on operation of the steam valves. The total condensate required for the period was 212,000 lb against a net theoretical of 165,200 lb, the difference being estimated as used by distribution loss, domestic hot water requirements, and boiler room auxiliaries.

Presented as Chart No. 2 is a flow chart from an installation of similar size which is also thermostatically controlled and which is 100% conventional, being approximately one-half standing radiation and one-half suspended unit heaters. The boiler plant for No. 2 consisted of three bent tube boilers—two in use—of 463 hp each with settings designed for operation to 300%. Both plants were in use the full 24 hours, both are fired with the same fuel, both are equipped with the same make of stokers and both are in charge of the same operating personnel under as nearly comparable operating conditions as it would be possible to find. Yet, the total condensate used on Plant No. 2 for the period was 315,000 lb with fluctuations in flow rate up to 10,000 lb per hour against a total theoretical of 167,000 lb, dis-



Charts 1 and 2. Flow charts from installations of similar size.

regarding transmission losses, hot water and auxiliaries.

Figures 2, 4, 6, etc., on Chart 1 and figures 5, 10, 15, etc., on Chart 2 indicate pounds of condensate per hour. Allowing for some variables which were calculated, such as slightly longer distribution system on No. 2, it would seem that approximately 35% less condensate was required on the radiant installation and that this alone would more than offset the pick-up allowance frequently made in selecting a boiler.

It would, therefore, seem entirely reasonable to eliminate the pick-up factor frequently used in boiler selection and to calculate the total heat requirements for radiant heating on a total temperature of 8 to 10F lower than for conventional types. This would be true on direct fired heaters and on steam exchangers where modulating controls are installed. Open and shut types of controls, not recommended for control of panels, of course might conceivably produce a condition where considerable pick-up would be necessary after long off periods and the installation of such controls must be taken into account in boiler selection.

2. What pick-up should be allowed for ground loss?

Usually a sized gravel fill, or fill of other materials containing a large percentage of voids, is used under a concrete slab and makes for a good insulation between the ground and the warm concrete. The percentage of voids depends on the compaction of the fill as designed for the floor loading, but unless compaction is carried to a high percentage of ultimum, the author has ceased figuring ground loss in pick-up allowance. On a recent case, a 6 in. gravel fill composed of ½ to 2 in. crushed rock hand tamped provided sufficient insulation so that with a floor temperature of 72F, a temperature of 58F was encountered at the bottom of the fill against a normal and encountered ground temperature of 55F one foot below the slab.

No definite calculations have been possible to date as to actual ground losses as the total heat supplied and as calculated from flow against temperature loss between flow and return water is less than the calculated heat loss of the structure, while a ground loss of any proportions would reverse these figures. More ground loss would certainly occur in proportion with a small slab than with a large one, but generally it would seem that such loss can be disregarded where materials of insulating properties are used for sub fill.

3. What is percentage of radiant and convected heat?

The author is unable to give definite percentages for the different panel locations, but the percentages below seem to be approximately those encountered in the field:

Ceiling panels — 92% radiant, 8% convection

Ceiling panels are designed for a higher temperature than floor or wall panels and the convection effect, which might theoretically be non-existent, is actually present to some small degree.

Wall panels — 40% radiant, 60% convection

With lower temperatures than ceiling panels but higher than floor temperatures, wall panels seem to have the highest percentage of convected heat.

Floor panels with their lower temperatures seem to reverse the percentages of the wall panels and definitely produce more sensible radiant effect on the person than other types. This is due to the fact parts of the body are very closely in contact with the floor panels and the radiant effect is instantly felt on parts of the body which may be lightly clothed, as ankles and lower limbs.

Thermometers suspended above the floor panels and which, exposed, register 72F have been found to drop quickly to 55F when shielded with a bright reflecting surface, thus registering the actual temperature of the air as heated by convection. The

temperature of the shielded thermometer, 55F, checks very closely with the calculated MRT on the subject installation and with the actual input of hot water as applied against the building loss at that temperature. The percentages, however, are not constant and seem to vary widely with outside conditions, resulting in higher percentages of radiant heat with lower outside temperatures.

4. What seasonal overrun of temperature is encountered?

No complaints of any moment have been registered from this source, but overruns of temperatures have occurred, especially in the higher altitudes where variations of 50F between day and night temperature frequently occur. Usually outside temperatures in lower altitudes are more stable with smaller variations and, overrun in lower altitudes, can be traced to the sun effect through windows and skylights. While sun effect through windows and skylights may be noticeable in that it produces a temporary higher temperature of a given section of floor, the area so affected is constantly being changed due to movement of the earth, and the overrun at any given point is of short duration.

It is readily understandable that with a temperature of 30F at 4 a.m. and temperature of 80F at 3 p.m., the mass of the concrete in a slab will often store enough heat for release during the period of rising temperatures to overcome the heat loss for several hours after temperatures begin to decline. Such variations occur only in high altitudes and for such a short proportion of the heating season that, coupled with the immediate drop in floor temperature when the system is shut off by thermostatic action, discomforts to personnel, if any, have not registered.

5. What are the best controls?

Controls for all radiant heating must be automatic and, for really successful operation, must have a device that will increase water temperatures with a decrease of outside temperatures. All pumps employed must be positive in action and fully able to deliver the designed amount of water to the system. The designer should bear in mind in selecting a pump that the viscosity of water drops from 1 at 68F to .432 at 150F and that pumps with large clearances of the usual circulating type, as used on hot water radiation, must be scrutinized carefully before specification on pipe panels.

Usual room thermostats have been found satisfactory for operating the pumps in connection with a relay. This method of starting pumps by thermostat in connection with the outdoor temperature water controller is preferred by the author over the continuous pumping operation with the water temperature the only variant.

If direct fired water heater is used, many suitable and accurate aquastats are available. If steam heat exchanger is used, the steam valve should be either modulating or multiple position to provide as great a range of capacities as possible. Chart No. 1 clearly illustrates off and on action of steam valves on heat exchangers. This effect would be greatly magnified if applied to a plant of smaller capacity and might have a detrimental result or effect on certain types of firing.

6. What is the effect of rugs and other insulating material on floor panels?

This question seems to worry many engineers who know that rugs, furniture, files and other equipment will be placed on or adjacent to their floor heating panels. Imagine, then, the author's surprise to find the entire floor space of a hangar heated by floor panels covered for several months with insulating wooden floor panels designed as a base for buildings used in arctic operations. These wooden panels, 4 x 8 ft in size, consist of a 2 x 4 frame covered with $\frac{7}{8}$ in. matched flooring on one side, $\frac{1}{2}$ in. laminated panels on the other with the space between the 2 x 4 joists packed with loose insulating material. In the hangar in question, the concrete floor is 4 in. high in the center of the hangar and the wooden panels touched the concrete only at that point being wedged up toward the outside walls to bring them level, thus providing another insulating air space.

It seemed impossible to devise a more severe insulating test for a radiant floor panel, yet the thermostats located above the insulating panels showed the same temperature as before the insulating panels were placed on the floor with only a 14F rise in concrete temperature and with the *top* of the insulated panels the same temperature as the floor had been previously. The panels were in place two months before the author found them and, while there must have been a time lag in again bringing the building up to design temperature, several of the personnel working in the space who were questioned, could shed no light on the lag and stated that if such lag occurred, they had not been aware of it. Since witnessing this accidental test, the author will never again worry over a few rugs or pictures placed on or in front of a heating panel.

7. What are final temperatures of radiant heated spaces?

Many variants affecting final temperature are encountered since such temperatures will depend on the use, occupancy, construction and location of the heated panels. Generally, an exposed thermometer must register within the accepted comfort zone regardless of the proportions of radiant heat and convected heat supplied.

True, shielded thermometers show lower temperatures than are believed necessary for comfort due to the lowered convection effect, and installations made on the basis of conventional heat loss are usually found to operate at much lower water temperatures than designed, thus providing a margin for temperature extremes far in excess of the usual arbitrary

allowance for pick-up. Calculations must, therefore, be made for providing from either or both types of heat the effect that might have been formerly derived from convection alone. The result will be greatly lowered, actual air temperature with radiant effect making up the remainder of the comfort temperature.

8. What economies of operation can be obtained?

Amazing economies of operation have frequently been reported from radiant heating panels over conventional types of heating. The economies so obtained are the composite result of many factors entering into this type of heating. One obvious reason would be the lowered final air temperatures possible. Another would seem to be the maintenance of a stabilized thermal condition without numerous start up periods. Another is the absolute control possible, and the even distribution of warmth throughout the entire heated area, thus preventing excessive temperatures in some spots to provide enough heat in others. Usually, however, the comparisons are made between radiant heat and former types that were not so adequately controlled and this must be taken into account in a cost analysis so that the user will not necessarily get the fixed idea of 50% or more savings as might seem indicated in some cases.

The actual savings, then, are the cumulative total of the factors mentioned and, in many cases, have been proved to be substantial both in fuel and maintenance, as there are very few devices on radiant heating requiring service or attention.

9. What is the occupant's reaction?

A recent survey of 50 persons engaged in working in a large panel heated space disclosed that all were comfortable, but that 47 did not know how the space was heated, although they knew that manipulation of the thermostat produced a change in the thermal condition. Three knew of the floor panels and had seen the heater room and control cabinets, but were unable to say where the key could be found to gain admittance to the room.

One mild complaint was recorded from a hand truck operator whose work required him to go out doors frequently for parts. His complaint was that he had to put on his overshoes when he went out in the snow each time, as his feet got cold more quickly than formerly.

In one large single space of 36,000 sq ft, double bunks for personnel covered the floor originally designed as working space and several hundred men were using the room for sleeping quarters. Those interviewed admitted that the condition was comfortable, but were ignorant and indifferent as to the source of heat; though one man said he wondered why the concrete did not feel as cold as he had noticed in previous quarters. The floor temperature was raised in this room from the 72F when used as working space to 82F during the personnel occupancy.

In all, everyone interviewed was comfortable and satisfied with the heating condition without any particular concern as to how it was accomplished and without any complaints as to cold or hot spots in the entire space.

10. What flexibility of design is possible?

There are several excellent articles extant as to the proper methods of figuring radiant heating and the author will not attempt to review or criticize them. Generally the formulae presented are conservative and results in the field are actually nearly double those recommended by some of the works presented.

The usual design basis seems predicated on a water temperature of 110F with a 10F drop. Any system designed on this basis will, when water temperature is raised to 140F, and a drop of 20F is accomplished, deliver nearly twice the designed heating. Several plans submitted to the author recently for suggestions have, therefore, had quite a considerable footage of pipe, more than experience shows is actually required.

Experience also seems to indicate that higher temperatures have no detrimental effect on good concrete slabs and it is often helpful to consider design for higher temperatures in cases where structural obstructions preclude placing the estimated amount of pipe on the 110F basis.

Norden Bombsights Have Heated Covers

The Norden bombsight is always dressed for the kill in some working clothes, it is revealed by General Electric. The working clothes consist of an electrically-heated cover which protects the intricate and delicate parts from the biting temperatures encountered by our airmen at high altitudes. The cold encountered at those altitudes would freeze up the parts of the bombsight, if it were not for this cover, thus hampering the precision required in the pinpoint bombing employed by the AAF.

The material for the outside covering is quilted, similar to satin puffs on beds. A coating of polyvinyl chloride resin on the outside waterproofs the cover.

A great variety of tests were made before the covers were put to practical use. They were tested by putting them in a specially built box. Dry ice and a blower attachment drove the mercury down to the required temperature level. Then covers were placed on racks in the box and thermocouples attached to the box, enabling the engineers to test the operation of the heating wires in the covers.

Refrigeration Drafting Symbols

NATHAN N. WOLPERT
Associate Editor, HEATING AND VENTILATING

Survey shows lack of universal drafting room practice. In particular, there are many symbols in use for indicating simple and special valves.

JUST as the stenographer enters in her notebook the mystifying lines and curves to represent words, the draftsman by means of simple symbols is using a shorthand code which not only is intelligible to him, but should convey the same message to

Fig. 1. Graphic methods for indicating solenoid valves.

others studying the drawing. Unfortunately, this is not always so.

For a symbol, to be effective, must carry the same message to an engineer in one section of the country as in another. In other words, there can be no halfway measures. A code of symbols that fails in its purpose and only becomes sectional in scope, adds confusion instead of tending to clarify matters. Fundamentally, the net result is that another drafting code is created.

For that reason, HEATING AND VENTILATING, in an effort to be of some service to the field, conducted a survey to determine actual conditions; to learn how badly confused the issue was, and the attitude of refrigeration and air conditioning engineers regarding a standard set of symbols. It is not the intent of this publication to advocate any particular code as the approved standardized symbols. That is a task for an engineering society or group truly representative of the industry. The magazine merely functions as a reporting agency.

Basis of Survey

There are some symbols that are in wide use although they cannot be considered as standardized. A set of the commonly used refrigeration and air conditioning drafting symbols was mailed to a representative group of engineers, and the men were asked to indicate which of the symbols they used in their work and to add their symbol for some special item, should their practice be different from that indicated.

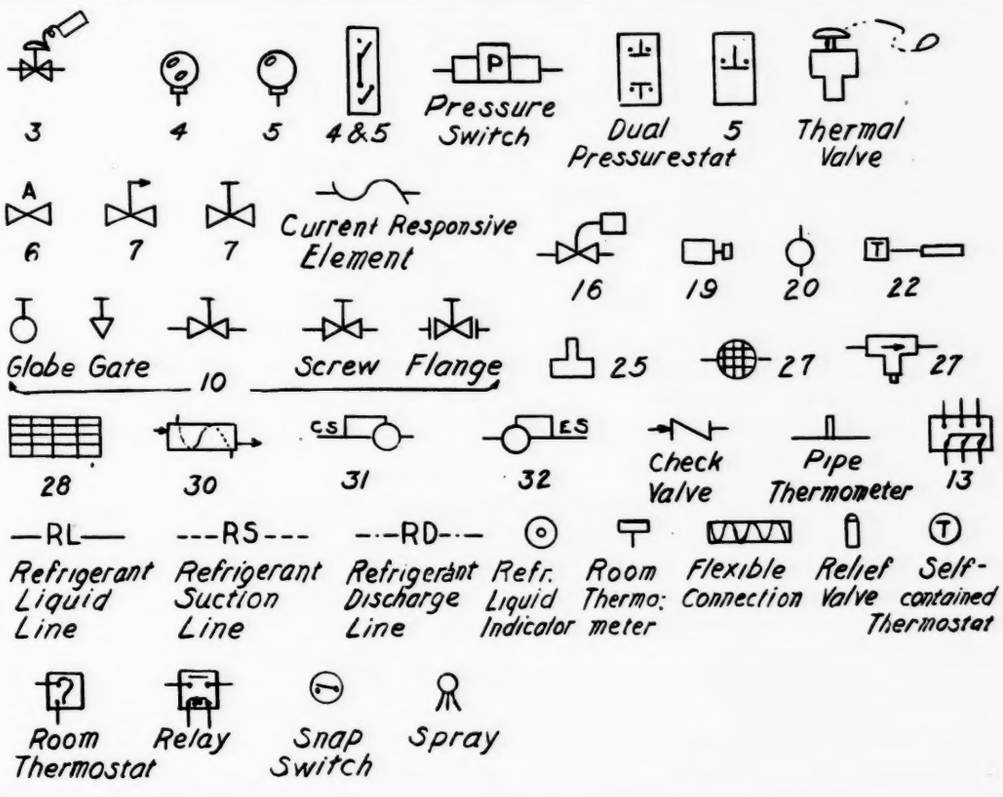


Fig. 2. Some of the symbols in use, other than those shown in Fig. 3. Numbers refer to the grouping in Fig. 3.

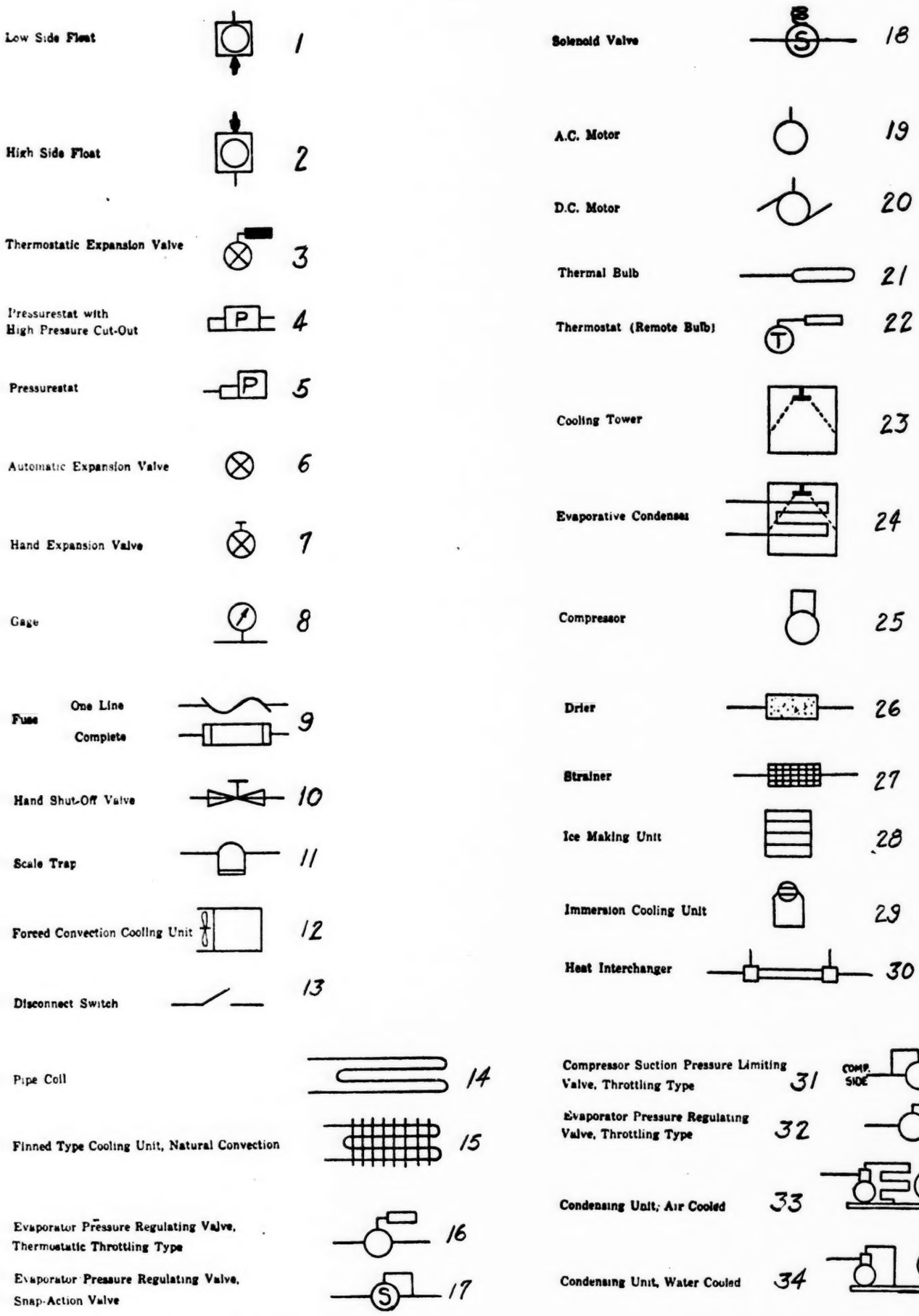

Low Side Float 1
High Side Float 2
Thermostatic Expansion Valve 3
Pressurestat with High Pressure Cut-Out 4
Pressurestat 5
Automatic Expansion Valve 6
Hand Expansion Valve 7
Gage 8
Fuse One Line Complete 9
Hand Shut-Off Valve 10
Scale Trap 11
Forced Convection Cooling Unit 12
Disconnect Switch 13
Pipe Coil 14
Finned Type Cooling Unit, Natural Convection 15
Evaporator Pressure Regulating Valve, Thermostatic Throttling Type 16
Evaporator Pressure Regulating Valve, Snap-Action Valve 17
Solenoid Valve 18
A.C. Motor 19
D.C. Motor 20
Thermal Bulb 21
Thermostat (Remote Bulb) 22
Cooling Tower 23
Evaporative Condenser 24
Compressor 25
Drier 26
Strainer 27
Ice Making Unit 28
Immersion Cooling Unit 29
Heat Interchanger 30
Compressor Suction Pressure Limiting Valve, Throttling Type 31
COMP. SIDE
Evaporator Pressure Regulating Valve, Throttling Type 32
EVAP. SIDE
Condensing Unit, Air Cooled 33
Condensing Unit, Water Cooled 34

Fig. 3. Set of refrigeration and air conditioning symbols sent to engineers for their comments. While commonly used, this is not a set of standardized symbols.

Symbols most generally used are as follows. The numbers refer to the listing in Fig. 3:

8. Gage
9. Fuse
10. Hand shut-off valve
11. Scale trap
13. Disconnect switch
14. Pipe coil
15. Finned type cooling coil, natural convection
21. Thermal bulb
25. Compressor

Some variance was expressed for the following symbols as differing from those illustrated in Fig 3:

3. Thermostatic expansion valve
4. Pressurestat with high pressure cut out
5. Pressurestat
6. Automatic expansion valve
7. Hand expansion valve
8. Gage
9. Fuse
10. Hand shut-off valve
16. Evaporative pressure regulating valve thermostatic throttling type
18. Solenoid valve
19. A.c. motor
22. Thermostat — remote bulb
25. Compressor
27. Strainer
28. Ice making unit
30. Heat interchanger
31. Compressor suction pressure limiting valve, throttling type
32. Evaporator pressure regulating valve, throttling type

The greatest difference is reported for the solenoid valve. Other means for indicating this are shown in Fig. 1. Variations for some of the other items are reproduced in Fig. 2. Attention is directed to the many ways for showing the common hand type operating valve.

In addition, the reports revealed the use of four symbols not shown in the HEATING AND VENTILATING chart. The chart illustrated is not complete in the sense that it includes all the drafting symbols used, but it does picture those commonly employed for items in general use.

Although the forms shown in Fig. 3 are far from being a national standard, they are being used by many companies. In fact, the engineer of one of the largest electrical companies wrote:

"The forms you presented are slightly different from those we use, but I think in most cases yours are better and we are willing to change over to their use."

Whether a change over to the code illustrated is made, or whether some other set of symbols is adopted, is beside the point. The real issue is to encourage study and action that will result in the use of standardized symbols approved by the proper engineering organizations. We are not alone in this belief. An officer of a large manufacturing company prominent in the refrigeration field, in commenting on the survey, wrote:

"Your endeavor to clarify this picture is certainly well worth while."

Ventilating a Tunnel During its Construction

An interesting feature of construction work on the new Adams Tunnel of the great Colorado-Big Thompson irrigation project under the Continental Divide in Colorado was the method of ventilation. This was effected by means of two blower systems, independent of each other, since the tunnel was bored from both ends simultaneously, by different contractors.

On the east side, ventilation was provided by four 100 hp reversible Root-Connorsville blowers, rated at 9,000 cfm each. One was stationed outside the portal and the others spaced at intervals within the tunnel. Air was exhausted through the heading for 45 minutes following a blast and for the rest of the time, an air balance was maintained between suction and blowing to keep the bore clear of fog.

A system of clocks and relays automatically controlled the reversals so that each one changed over in order and at the proper time. A single 20 in. pipe line conveyed the air, this being extended as the cut proceeded. At 8 miles in, the blowers delivered 7,000 cfm of air.

On the west side, blowers of 12,000 cfm capacity and two 2 in. pipe lines were employed. Only one booster unit was needed on this side because of the larger blower capacity and the use of a double line system. This booster was stationed 21,300 feet from the portal during the final drilling.

With start of the concrete lining work, all air pipe was removed and ventilation was effected by forcing air through the entire tunnel by huge blowers at each end. Some 1,800,000 man-hours went into the drilling of the bore, and approximately 310,000 cubic yards of rock were excavated. Blast holes drilled totaled 480 miles, and 2,480,000 pounds of dynamite were required for blasting.

The Adams Tunnel is the longest ever driven from only two points of access and will carry water from the western slope of the Continental Divide to furnish supplemental irrigation for 615,000 acres of rich farming land in northeastern Colorado. It is a part of the $50,000,000 U. S. Bureau of Reclamation Colorado-Big Thompson project.

—F. N. Hollingsworth

Atmospheric Pollution Due to Gas

ARTHUR C. STERN

TWO general classes of contaminants are found in the atmosphere, namely, solid particulate matter such as dust, smoke, cinder, fly ash, pollen, bacteria, molds, yeasts and spores; and gases abnormal to the atmosphere plus the vapors of liquids other than water. Water vapor is excluded because humidity is not considered an atmospheric contaminant. Mists and fogs, while not pollution agents, are, however, greatly influenced by the presence of solid or gaseous pollution.

The atmosphere of rural areas serves as the norm against which gaseous pollution is measured in that an atmosphere may be considered contaminated when it persistently contains (a) gases not components of normal rural air or (b) high concentrations of gases which occur in lower concentrations in normal rural air. The choice of the usual atmosphere of the countryside rather than that of the ocean or of polar regions as the basis for determining pollution is made so as not to charge against the atmosphere as contamination the gases resulting from equilibrium in the biological processes of life and death, growth and decay, notably carbon dioxide and ammonia.

It will be noted that the above definitions include the requirement that the occurrence of the abnormality must be persistent. This is done because such accidental or infrequent discharges as occur when a cylinder of bottled gas ruptures are, although unquestionably serious, scarcely susceptible of the sort of engineering control as will be discussed. Another requirement which is implicit in the characterization of an atmosphere as "polluted," is that the effect be observable over a sufficiently widespread area to be truly "atmospheric" in scope. Thus the air inside a room or building may be highly charged with an undesirable contaminant at the same time that in the atmosphere outside the walls and windows, the same substance is in such a highly dilute state as to be undetectable by any known means. In these instances it is the room air and not the atmosphere that is polluted. Typical are the many cases where either because of the lack of a ventilating system or of maintenance of too high a recirculation ratio in the system installed, contaminants are allowed to build up to objectionable concentrations in the air of enclosed spaces.

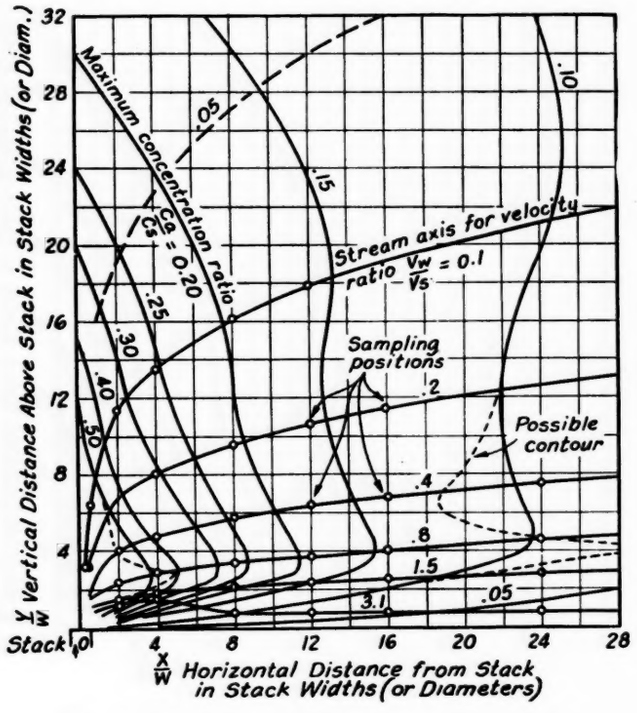


Fig. 1. Maximum relative gas concentration in undisturbed streams in the vicinity of a stack.

Pollution from a Nearby Stack

Every time a contaminant gas or vapor is discharged from an industrial exhaust system, a stack, a chimney or even a factory window, a potential pollution problem is created. However the atmosphere provides such a vast reservoir of diluent and possesses such marvelous means of self purification that it is only rarely that the potential problem becomes a real one. Perhaps the most frequently occurring and the most easily corrected of these problems are those where the contaminant enters the windows, doors or air intakes of a building immediately adjacent to that from which it was discharged. This constitutes a problem whenever the atmosphere cannot sufficiently dilute the discharge during its short transit from effluent outlet to adjacent air intake. In some instances, particularly those of discharge from low industrial exhaust system discharge ducts, the effluent may even enter an air intake of the same building from which it was discharged. When such reentering occurs, the obvious solution is relocation of either the discharge stack, the air intake, or both so as to avoid external recirculation in even the worst wind or wind eddy condition that can exist.

Gas Concentrations

In most cases where winds carry a well defined jet of effluent directly into the window or air intake of a nearby downwind building, the laws of jet diffusion determine the concentration of the contaminant in the gas stream. A recently published study

by the U. S. Bureau of Mines[1] has given us data for predicting the concentration of gas or vapor that may be expected within 50 stack diameters downwind of a vertical stack. In general, within a wide range of ratios of wind velocity to stack velocity (0.1 to 3.0), it was shown (Fig. 1) that the maximum predictable concentration, which occurs along the axis of the effluent stream, and is expressed as a percentage of the stack concentration, will not exceed 15% at 15 stack diameters, 10% at 25 stack diameters, and 5% at 50 stack diameters downstream from the stack. These percentages are for unobstructed airstreams without buildings in the wind path, a condition which would prevail when discharging from a stack substantially higher than all immediately adjacent buildings.

When buildings are close enough to the stack to create substantial eddies in the discharge jet, the likely concentrations are from one-fifth to one-tenth those shown. In other words, the chances of the maximum concentration at a building downwind from a stack exceeding 2% of stack concentration at 25 stack diameters and 1% at 50 stack diameters downstream is somewhat remote. When concentrations of this order of magnitude are too high, the solution is either to decrease stack concentration to the point where the building concentration becomes sufficiently low or to increase stack height so that the streamlines from the stack in the most unfavorable wind pass over all downwind buildings.

Pollution from a Distant Stack

The next general type of problem is that in which the discharge from a particular stack, usually somewhat isolated and almost invariably so high that no building is within jet range of the stack, pollutes by eddy diffusion a downwind area. Single stack sources are usually either smelters or large steam power plants. Actually they may consist of a battery of stacks so close together that from a mile or more away they act as if they were a single stack source. When smelters or power plants are in rural areas they usually constitute the only important air pollution source in the area. When the plants are situated in metropolitan areas, their pollution is superimposed upon the generalized pollution of the area. Bosanquet[2] has shown that, on theoretical grounds, eddy diffusion, unaffected by local building downwash, will cause a ground concentration X, at distance d downwind and y crosswind from a chimney of height h to result from the emission of a mass of contaminant M per unit time into a wind velocity v, according to the following equation:

$$X = \frac{40M}{d^2 v}\, e - \frac{h^2 + y^2}{0.016\, d^2} \qquad \textit{Eq. (1)}$$

e is the Naperian base; distances d, h and y are in meters; M is in milligrams per second; X is in milligrams per cubic meter of air and v is in meters per second.

Fig. 2 (Ref. 3) shows results of a typical solution of this equation. Analysis of the equation shows that highest ground level concentrations occur at from 8 to 10 chimney heights from the stack and that theoretically there is not much to be gained by increasing chimney heights much above 300 feet. It can further be theorized that only at distances of less than 20 stack heights downwind of a stack is ground level concentration influenced by changes in stack height. If concentrations from an already high stack are excessive at ground level points in excess of 20 stack heights away, further increase in stack height should therefore not improve conditions appreciably. Actual experience is, however, somewhat at variance with this theory in that the effectiveness of high

[1]McElroy, G. E., Brown, C. E., Berger, L. B., and Schrenk, H. H., Dilution of Stack Effluents, Bureau of Mines Technical Paper 657, 1944.

[2]Bosanquet, C. H., Eddy Diffusion of Smoke and Gases in the Atmosphere, Journal of the Institute of Fuel, Vol. VIII, No. 39, pp. 119-152, Feb. 1935.

[3]Pearson, J. L., Nonkebel, G., and Ulander, P. H. N., The Removal of Smoke and Acid Constituents from Flue Gases by a Non-Effluent Water Process, Journal of the Institute of Fuel, Vol. VIII, No. 39, pp. 119-152, Feb. 1935.

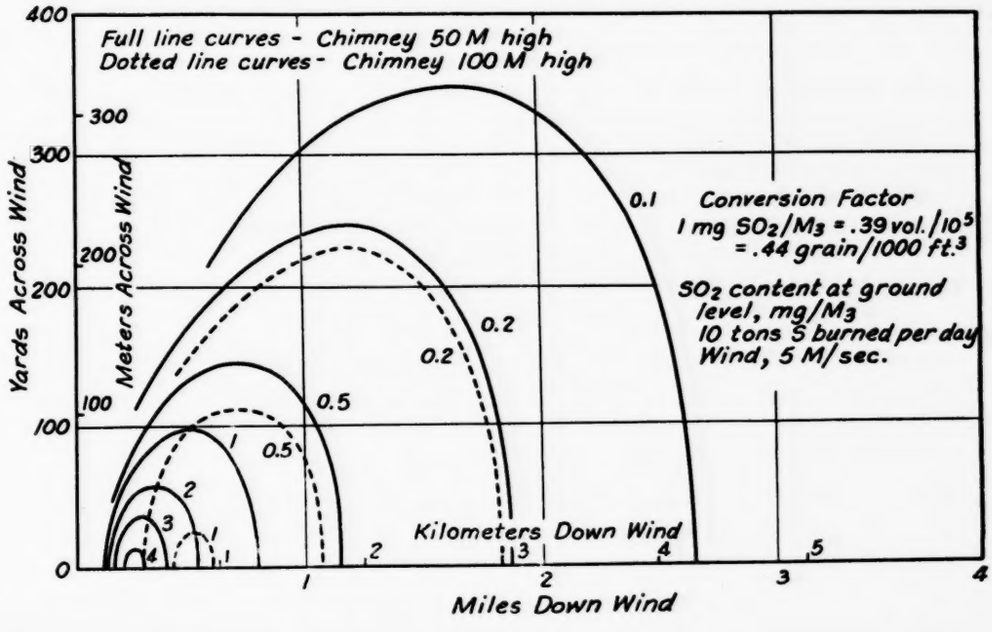


Fig. 2. Ground concentration distribution of SO_2 from chimneys of different heights.

TABLE 1.—AVERAGE ANNUAL ATMOSPHERIC SO_2 CONCENTRATION, P.P.M.

Miles from Center	Pittsburgh	Philadelphia	Washington	St. Louis	Detroit
0-5	0.078	0.035	0.009	0.186	0.037
5-10	0.038	0.021	0.003	0.081	0.022
10-15	0.023	0.015	0.001	0.044	0.009
15-20	0.032	0.018	0.002	0.031	0.005
20-25	0.016	0.012	0.001	0.025	0.006
25-30	0.024	0.011	0.004	0.018	0.007

stacks in abating stack discharge nuisances is greatly influenced by local topography and the presence of nearby tall buildings.

The best method of choosing stack height is, therefore, to study in a wind tunnel the discharge stream from a scale model of the stack and its environs, particularly with regard to the prevention of nearby downwash from the stack due to local eddies.

Both wind tunnel studies and actual field experience have shown that stack heights equaling or exceeding 2½ times the height of surrounding buildings or hills will in general prevent such downwash and will allow general atmospheric eddy diffusion to take place. Where downwash occurs concentrations will approach or exceed those previously noted after jet diffusion from a single stack.

Sherlock and Stalker[4] conclude "downwash is accomplished in two steps, the first of which is the downwash induced by the tip vortexes at the top of the stack combining with the vertical vortex cylinders in the wake of the stack; the second is the dispersion of gas within the turbulent air mass above and behind the power station buildings."

To avoid downwash it is necessary either to prevent the vertical vortex cylinder from making contact with the turbulent air mass and thus acting as a flue, through which stack gases that enter the vortex top are sucked into the turbulent air mass, or if such contact is established, to prevent the stack effluent from entering this vortex in the first instance. The former is accomplished by maintaining a distance from the building top to the top of the stack great enough to prevent contact in the highest wind likely to occur. The latter is accomplished by maintaining stack velocity equal to or greater than wind velocity.

$$X = \frac{9M}{v} \log e \frac{d+b}{d} \qquad \text{Eq. (2)}$$

M is in milligrams per second in the area; d is measured downwind from the leeward side of the area and b is the dimension of the area swept by the wind, in meters.

It should be noted that Equation 1 does not include any factor to account for the fact that either high stack discharge velocity, high flue gas temperature or both acting at the same time, tend, by projecting the discharged flue gas skyward, to increase the effective height of the stack and thus decrease ground level gas concentrations more than would be calculated on the basis of stack height alone. Some smelter stacks of 450 feet and over have been built and are successful in minimizing ground level contamination. However, there is reason to believe that a shorter stack might have been equally successful in a number of these plants.

[4]Sherlock, R. H., and Stalker, E. A. The Control of Gases in the Wake of Smokestacks. Mechanical Engineering, June 1940, p. 455, Vol. 62.

Pollution Downwind from an Industrial Area

In contrast to problems of pollution traceable to a particular stack or cluster of stacks are those in which it is impossible to isolate one stack or plant as the source because there are such a large number in the area discharging the same effluent. Here again dilution of the contaminant is by means of generalized eddy diffusion, so that concentrations downwind from the area may be estimated by another equation by Bosanquet:

$$X = \frac{a^1 M}{d\,v} \qquad \text{Eq. (2)}$$

Here M is the mass of contaminant emitted per unit time in the area, and d is measured downwind from the leeward side of the area. This is the mechanism, well illustrated by Table 1, (Ref. 5), of suburban pollution from metropolitan areas and is almost always at a lower level of intensity than exists in the metropolitan area from which it comes.

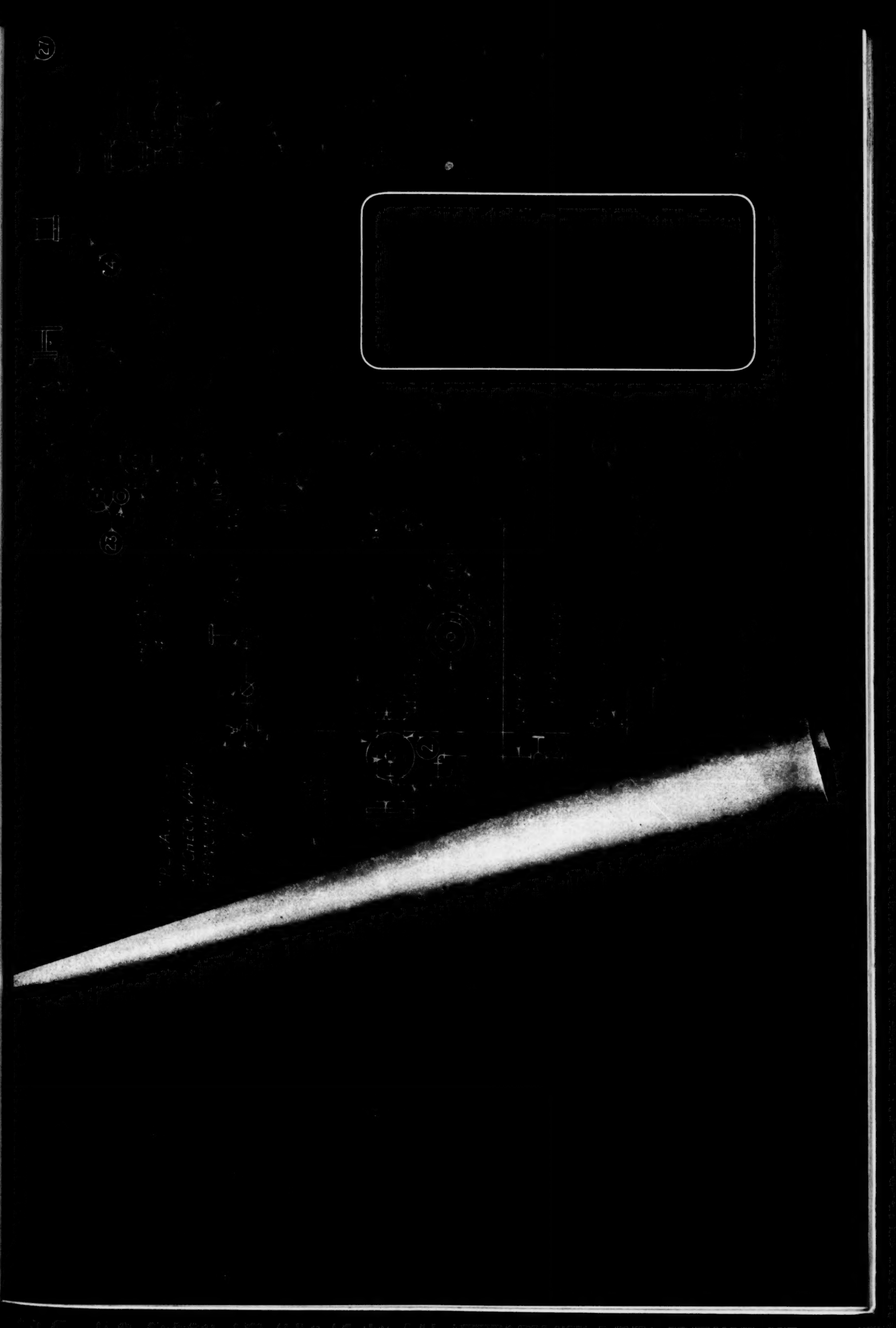
Pollution Within an Industrial Area

It should be noted that near the center of a metropolitan area of uniformly distributed pollution sources, wind direction should have very little effect on concentration, since a wind from any direction will pick up about the same quantity of contamination between the edge of the area and its center. Concentrations of gases in the atmosphere of this type of an area will be greatest when the vertical atmospheric temperature gradient causes a low "ceiling" over the area at the same time as wind velocity is low. All the contaminants discharged in the area will thus be confined in a box of height equal to the "ceiling" height and base equal to the area. The "box" will be ventilated by as many air changes per hour as the ratio of wind velocity, in miles per hour, to any representative horizontal dimension of the area, in miles in the direction of the wind.

If we know the rate of contaminant discharge in the area and the area dimensions, reasonable assumptions made of the ceiling height and wind velocity will allow an estimate of the severity of contamination of the air in the box. Estimates made

[5]Air Hygiene Foundation of America, Concentrations of Volatile Sulphur Compounds in Atmospheric Air. Special Research Bulletin 1, Parts 1 and 2, 1937-1938.

(Concluded on page 117)



Electrothermal Space Heating and Air Conditioning

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SPACE heating of dwellings has been one of the prime necessities in improved living conditions and one that has received considerable study from the earliest time. As various heating methods were developed, from the early open fireplace to modern heating equipment, utility has been the prime design consideration. Not until recent years has any attention been given to what one could call pleasing design.

During the last 20 years in the Pacific Northwest, experiments have been conducted continually and many practical installations have been made utilizing electric energy for heating. However, these installations were almost entirely of the radiant and convection type heater. This type heater requires an uninterrupted supply of electric energy. In 1935 at the City of Grand Coulee, adjacent to Grand Coulee Dam, an electrical heat storage installation was constructed and placed in operation utilizing granite boulders for the heat storage medium. This installation was operated for approximately two years on an experimental basis, and the results of the experiment were fully outlined in a report by the State College of Washington Experiment Station. Also in the Pacific Northwest, several installations of storage heater, utilizing hot water, are in operation with varying degrees of success.

This heating is coordinated with a utility problem that has existed since the early days of electric distribution. It is the problem of filling in valleys and reducing peaks in daily load curves of utility systems. The daily load factor has a direct bearing on service cost. An increasing load factor decreases cost of service. Incentive rates have been established by utilities to encourage use of electric service during off-peak hours, as witnessed by special rates established for hot water heating and the development of devices for controlling use of electricity during predetermined hours.

The most promising areas in the United States and Canada, at the present time, for the use of electric heating are those served by low-cost hydroelectric power. As the public is educated to the advantages of home insulation and the conservation of heat by better construction methods and materials, electric heating with its accompanying cleanliness will tend toward more extensive use of this source of heat energy.

The increased cost of oil, coal, and wood fuels, and the severe curtailment of oil is an incentive for the use of electric energy in space heating.

These conditions led the author to consider the development of a method for utilizing an electric energy heat storage system which would permit the use of off-peak electric energy obtained principally during the night hours.

In designing the electrothermal storage system for space heating, consideration was given not only to heating but also to the problem of

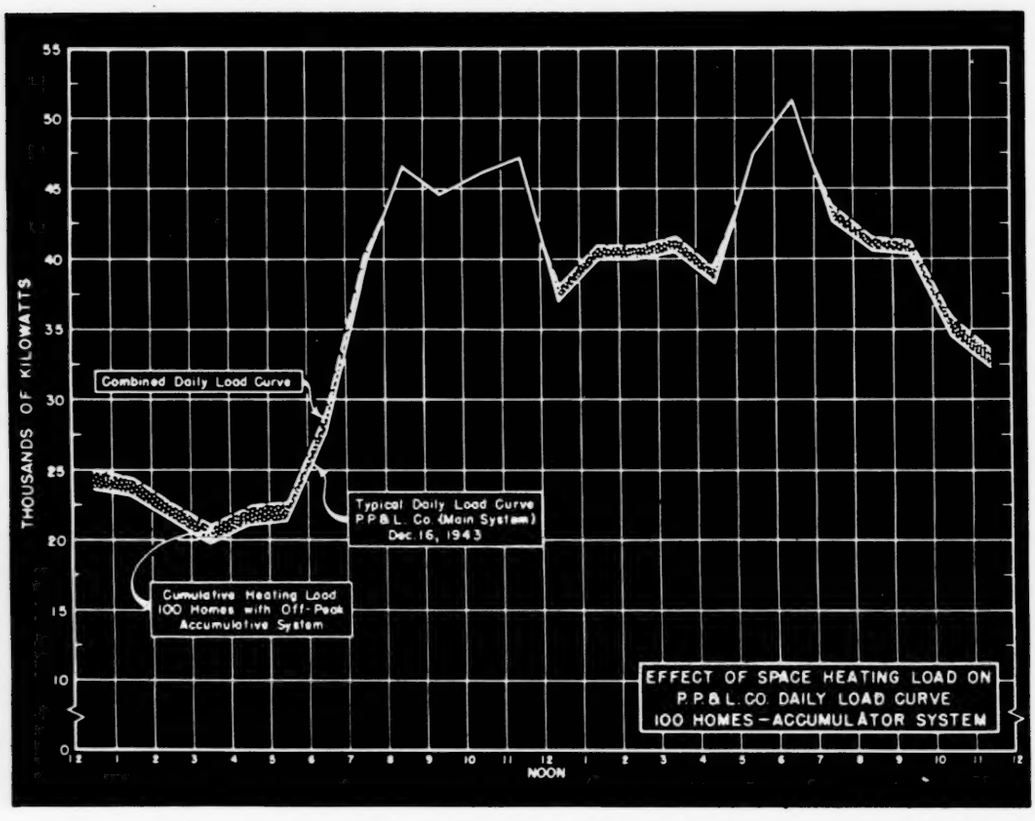
THOUSANDS OF KILOWATTS
55
50
45
40
35
30
25
20
15
10
0
Combined Daily Load Curve
Typical Daily Load Curve P.P.&L. Co. (Main System) Dec. 16, 1943
Cumulative Heating Load 100 Homes with Off-Peak Accumulative System
EFFECT OF SPACE HEATING LOAD ON P.P.&L. CO. DAILY LOAD CURVE 100 HOMES—ACCUMULATOR SYSTEM
12 1 2 3 4 5 6 7 8 9 10 11 NOON 1 2 3 4 5 6 7 8 9 10 11 12

Fig. 1. Typical daily load curve of a utility system.

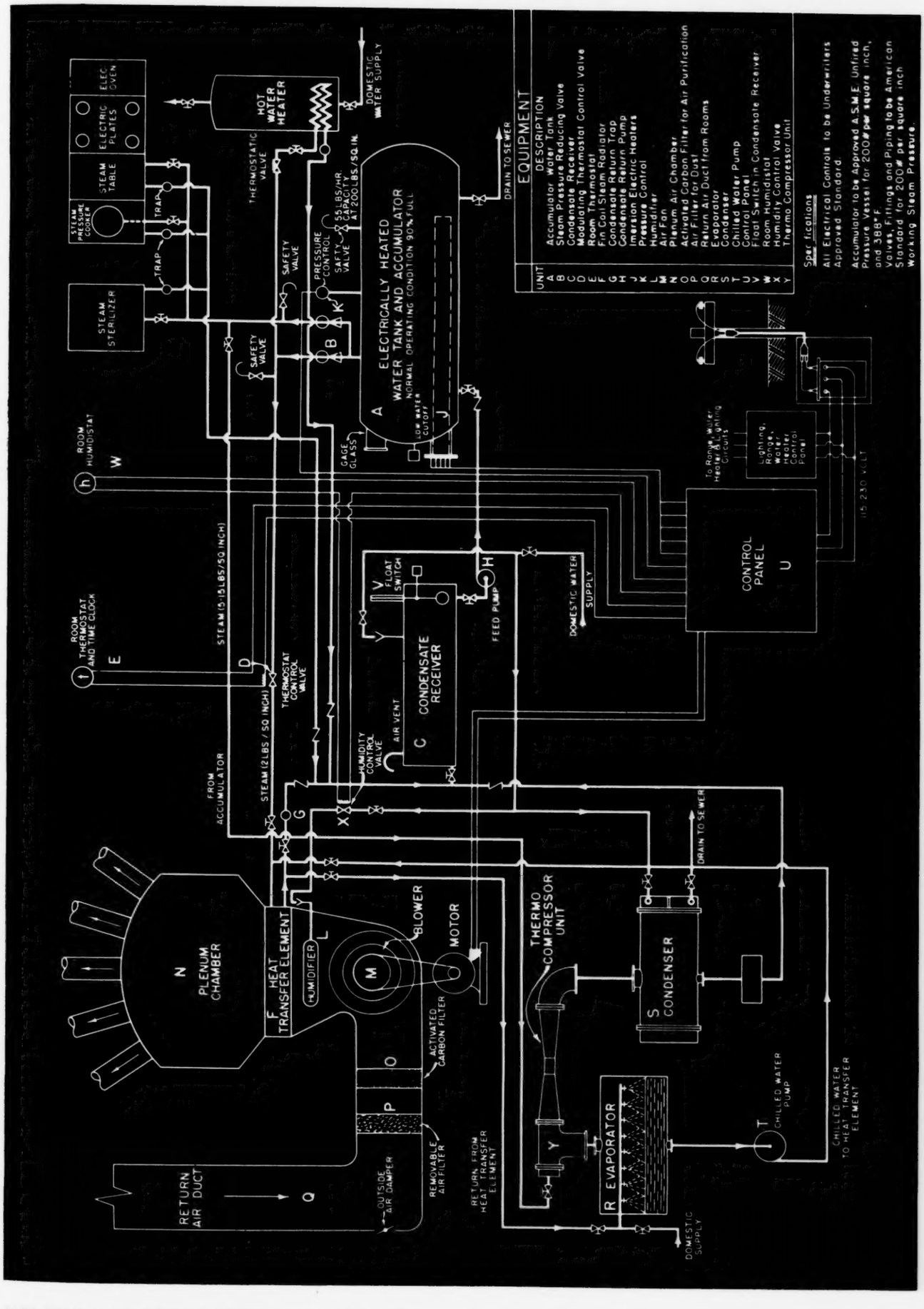

Fig. 2. Schematic diagram of complete electrothermal off-peak accumulator heating and air conditioning system.

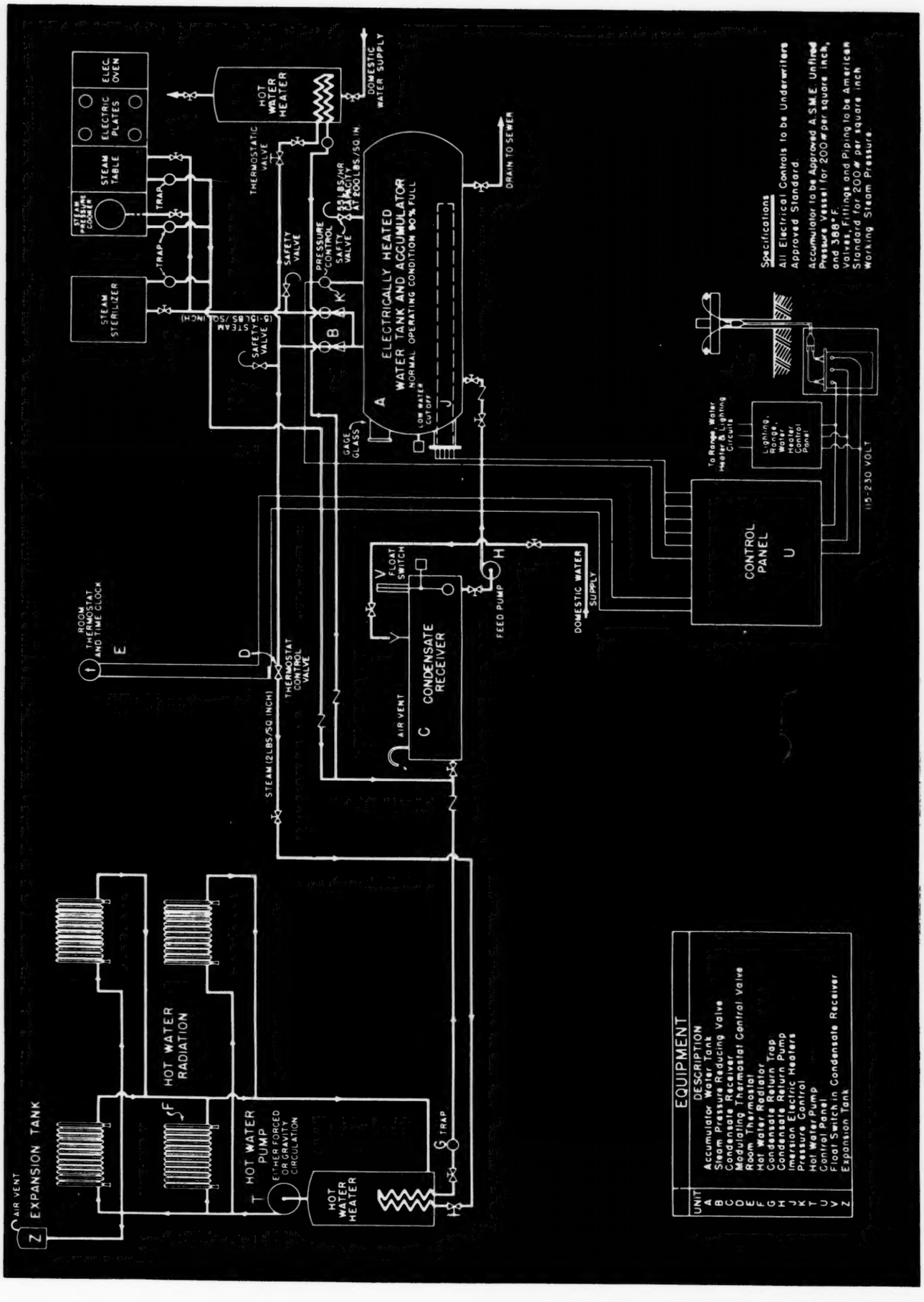

Fig. 3. Schematic diagram of electrothermal off-peak storage heating system as applied to low-pressure and vapor steam radiation systems.

air conditioning in as simple a manner as possible, bearing in mind that the electrical method was the one offering the greatest possibilities for regions having low-cost hydroelectric energy. Therefore, it was decided that a medium for heat storage should be selected which offered extreme flexibility and provided for the storage of a large amount of heat energy in the minimum of space. Water under moderate pressures and temperatures seems to offer the best solution to this problem. Therefore, a system was devised wherein water is stored in an unfired pressure vessel under a pressure of 200 lb per sq in. and at the saturated temperature corresponding to the above pressure. Electrothermal space heating is based upon fundamental thermodynamic principles, using a common fluid (water) for the storage of heat generated by electric energy. The heat is stored in the fluid under pressure.

As pressure in the vessel is reduced, the sensible heat of the liquid is converted to latent heat of vaporization which produces steam in the vessel. Expansion of the steam in the vessel to the final low pressure used in the heat exchanger is an isothermal expansion at constant temperature. Vapor in the heat exchanger at two lb per sq in. gauge pressure, or 17 lb per sq in. absolute pressure, has a latent heat of 965.5 Btu per lb. This latent heat from the vapor is transmitted to the heating and ventilating air as the latter passes through the fin tube coils.

If the unit is located in the basement of a dwelling, any resulting radiation will not be lost for the reason that the small amount of heat radiated will be utilized to warm the basement air and the floor above, thus reducing the extent of the building heating loss.

An approximate method is given to determine the quantity of liquid required to store the predetermined amount of heat to meet the building heat losses over a predetermined number of hours at a uniform rate. In the approximate method, arithmetical mean temperature differences are used in lieu of logarithmic mean temperature differences purely for convenience.

As an example, it is desired to store 300,000 Btu of heat energy to be used at a uniform rate for ten hours. (A greater or lesser heat release can be used in a lesser or greater time as desired.

The quantity of steam that will be used to liberate the required heat will be:

$$\frac{\text{Hourly heat release} \times \text{Time}}{\text{Enthalpy of evaporation}} = \text{Pounds of steam}$$

$$\text{thus } \frac{30{,}000 \times 10}{965.5} = 311 \text{ lb steam}$$

Then to vaporize this quantity of steam from the stored water in the unfired pressure vessel, the total quantity of water required will be as follows:

Initial pressure in vessel = 200 lb per sq in.

Final pressure in vessel = 5 lb per sq in.

Arithmetical mean pressure in vessel = 102.5 lb per sq in.

Enthalpy of evaporation at mean pressure = 879.25 Btu/lb.

Enthalpy of saturated liquid at initial pressure = 361.91 Btu/lb.

Enthalpy of saturated liquid at final pressure = 189 Btu/lb.

$$\text{Weight of Water} = \frac{\text{Pounds of steam} \times \text{enthalpy of evaporation at mean pressure}}{\text{Enthalpy of liquid at initial pressure—enthalpy of liquid at final pressure}}$$

$$\text{Weight of water} = \frac{311 \times 879.25}{361.91 - 189} = 1{,}575.65 \text{ lb.}$$

Thus it is evident that only a small quantity of water (approximately 212 gallons at the mean pressure and temperature) is required for the given heat storage.

By the use of this method of off-peak heat energy storage, economical use of a utility's distribution system can be obtained. The present distribution systems of the various utilities are being utilized at a relatively low load factor. Greater use of these facilities during periods when the load factor is low permits the fullest possible use of the system with only minor expansion of the distribution facilities. Any added use of these facilities is a source of additional revenue to the utility with only slight additional cost.

Another very important factor of the off-peak storage system is that it does not require the utility to guarantee uninterrupted service. This factor has caused utilities in general to back away from space heating loads because additional equipment is required on their part to render this uninterrupted service. Normal outages would in no way affect the heating of the dwelling, if the storage system is in use.

As a general thing, the rate structure of a utility is set up to carry all fixed charges and operating expenses, plus a reasonable profit on the distribution of energy at a moderate load factor. Therefore, the additional energy distributed over their existing facilities without much additional cost is very desirable. Revenues derived from this additional energy will result in a greater net income, which in turn can be shared with the users of electric energy, thus benefiting both the utility and the user.

Fig. 1, a typical daily load curve of the Pacific Power & Light Company (Main System) for December 16, 1943, shows the night load between midnight and 6:30 a.m. to be less than half the peak load during the evening hours from 5:00 p.m. to 7:00 p.m. On this load curve, the morning peak between 8:00 a.m. and 12:00 noon is slightly lower than the two-hour peak between 5:00 p.m. and 7:00 p.m. However, some of the systems reverse this order and have a higher peak during the morning hours, but the duration of both morning and evening peaks is approximately as shown on this load curve.

It is the object of the off-peak electrothermal heating system to use as much as possible of the available energy represented by the valleys in this curve for space heating purposes. The shaded section above the load curve represents the energy that would be used by 100 homes similar to the one that was chosen as a demonstration unit at the Midway Substation of the Bonneville Power Administration, which is located in the area of Central Washington served by the Pacific Power & Light Company. It is estimated that the off-peak energy represented by the valleys of this load curve could be used to heat 1,500 five-room or six-room dwellings.

The electrothermal off-peak heat storage system was designed to meet all of the safety and insurance requirements of the State of Washington and building heating codes in Seattle and Tacoma, as well as the code of the American Society of Mechanical Engineers for unfired pressure vessels. All electrical equipment used in this system has been approved by the National Underwriters' Laboratories.

Principal Equipment

A general description of the electrothermal space heating and air conditioning equipment consists of the following:

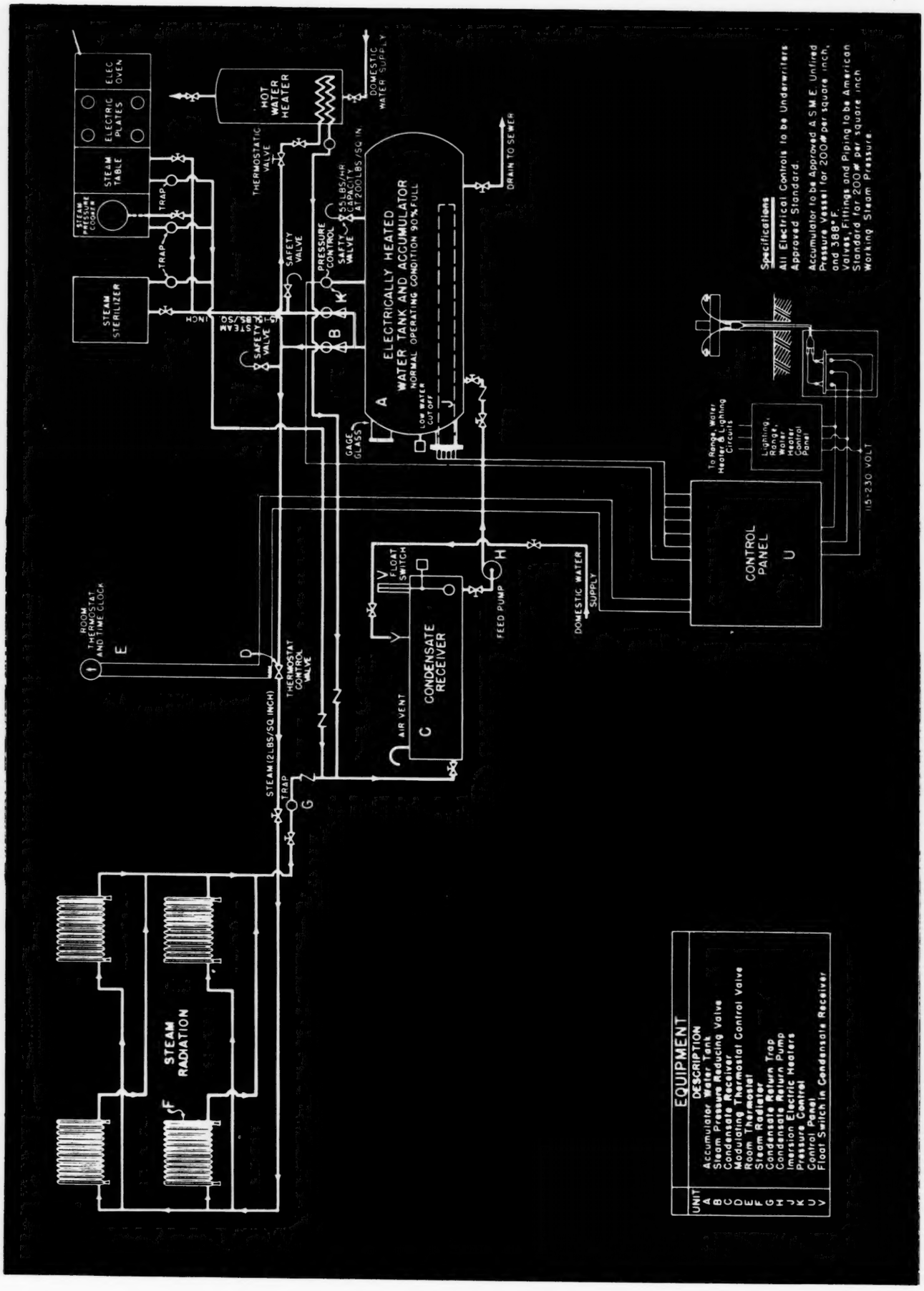

Fig. 4. Schematic diagram of electrothermal off-peak storage heating system as applied to gravity and forced circulation hot water heating systems.

The main items of equipment are a super-heated hot water accumulator, immersion electrical heaters providing the source of heat, a reducing valve for automatically releasing the heat energy from the accumulator to a lower pressure level, a heat transfer element for transmitting the heat energy into the air used for heating the dwelling, a condensate receiver to store the condensate until such a time as it is returned to the accumulator, an electrically-controlled feed pump, a thermostat for maintaining a constant predetermined temperature in the dwelling, a humidistat for maintaining the relative humidity at a predetermined level, renewable dust filters, activated carbon filters, and an air-circulating fan.

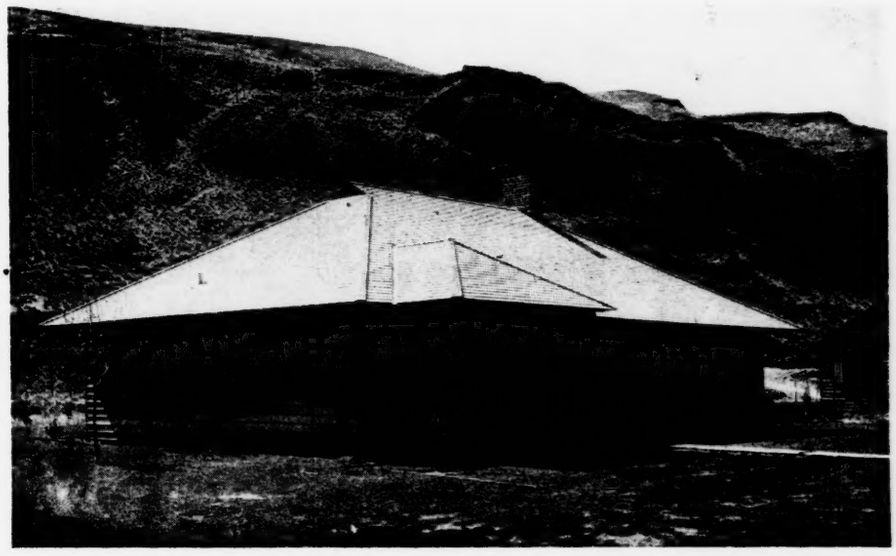

Fig. 5. Chief operator's cottage at Midway Substation.

Operation for Winter Heating

A schematic diagram of the electrothermal off-peak accumulator system is shown in Fig. 2. A description of the method of operation of this system follows:

The accumulator *A* is an unfired pressure vessel filled 90% full of water under normal operating conditions. When fully charged, pressure in the accumulator is maintained at 200 lb per sq inch and 388F. The accumulator is built according to specifications of the latest unfired pressure vessel code as published by the American Society of Mechanical Engineers. This insures a pressure vessel having a high factor of safety for use in dwellings. The vapor above the water in the accumulator is released through a pressure-reducing valve *B*, which reduces the pressure from 200 lb to two lb per sq in. The two lb per sq in. steam line is provided with a safety valve in order to limit the pressure in this part of the system to not more than 5 lb per sq in.

Thermostatic control valve *D*, which is under control of the room thermostat and night setback time clock *E*, regulates the steam flow to the heat transfer element *F* as governed by the room temperature. Valve *D* is a modulating valve permitting continuous flow of varying quantities of steam as required and is not the "on and off" type.

As the steam is condensed in the heat transfer element, the flow of condensate is controlled by a thermostatic trap *G*, which allows only the liquid to pass. The condensate is returned to the condensate receiver *C*, where it is stored until such a time as the liquid level has risen to a predetermined point. At this predetermined point, the float switch *V* energizes the feed pump circuit and permits the feed pump *H* to return the condensate to the accumulator *A* at the slow rate of approximately 0.25 gpm. The condensate cannot be returned to the accumulator unless the heating elements *J* are energized.

This low rate of feed to the accumulator was fixed so that this water could absorb nearly all of the required heat energy from the immersion electrical heaters, rather than deriving it from the high-temperature water in the accumulator. It is evident that with this closed circuit, there will be little or no loss of water which would require an appreciable amount of make-up water. Because of the closed circuit, there is no accumulation of solids from the water to form objectionable scale in the system.

Safety features in connection with the hot water accumulator are a safety valve with outside discharge, which has a steam flow capacity considerably in excess of the heat generating capability of the electrical immersion heaters *J*, and an electrical pressure control *K* which interrupts the power circuit to the electrical heaters when the pressure in the accumulator has reached the predetermined pressure of 200 lb per sq in.

Air required to transmit heat from the heat transfer element to the rooms of the dwelling is propelled through the heat transfer element into the plenum chamber *N* by the forced air-circulating fan *M*. From this point, air is conducted to the rooms of the dwelling by well-designed and well-constructed air ducts. Return air from the rooms is conducted through the return air ducts *Q*, and is passed through removable dust filters *P*, which remove all dust and lint from the air. This air then passes through activated carbon filters *O*, which remove all household odors.

Outside air is admitted to the suction side of the fan in sufficient quantities only to maintain the oxygen and the carbon dioxide contents of the air at normal levels. By recirculating the air in the system, with only this small addition of outside air, considerable heat is saved as well as maintaining a slight positive pressure inside and thus reducing infiltration of outside air.

To maintain the proper relative humidity in the dwelling, a humidifier *L* is provided. Moisture for humidification is provided by a fine spray nozzle that injects the water into the air stream in the form of a mist. This mist then passes through the heat exchanger and is completely vaporized and mixed with the heated air. The flow of water to the spray nozzle is through valve *X*, which is under the control of room humidistat *W*.

To govern the flow of electric energy to the system, time switches are provided to determine the point at which the energy is cut off during the peak period of the day and then re-established during night hours. A second time switch is provided which will permit a limited amount of energy to be taken during the off-peak period between 12:00 noon and 5:00 p.m. Controls are so operated that the various heaters are energized in groups. The entire heater load cannot be thrown on the system at one time.

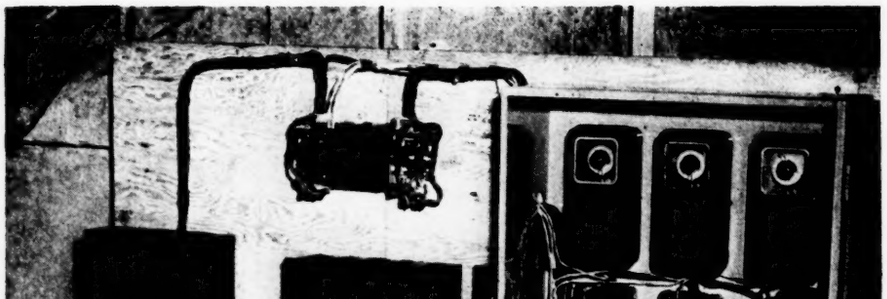

Fig. 6. Control panel.

This function is controlled by a motor-driven step controller which permits the energization of the first 4 kw of heater capacity, then the next 6 kw of heater capacity, and finally the last 4 kw. Should the demand for heat during the day vary from the maximum, the step controller will reverse its direction of rotation and de-energize the heater in steps in order that the predetermined pressure of 200 lb per sq in. in the accumulator will not be exceeded.

Operation for Summer Cooling

For summer cooling the steam supply to and condensate supply from the heat transfer element is shut off by closing valves in those lines; two valves controlling the chilled water to and from the heat transfer element are open; a summer switch governing the automatic controls is placed in the summer position. This automatically energizes the summer cooling equipment and controls.

Cooling is accomplished by circulating chilled water through the heat transfer element *F*. This chilled water is produced by a small vacuum water-refrigerating unit which comprises a thermo compressor unit, condenser and evaporator. Steam from the accumulator is utilized to operate the thermo compressor *Y*, which together with secondary evactors produces a vacuum in evaporator *R*.

Return water from the heat transfer element is sprayed into the evaporator, which operates at a high vaccum, causing the evaporation of a portion of the returned water. This evaporation removes the heat from the balance of the return water, reducing its temperature to approximately 45F. The water vapor evaporated, plus the steam supplied to the thermo compressor, is carried over to the condenser *S*, which is cooled by circulating water from the domestic water supply.

Condensate from the condenser is returned through a vacuum trap to the condensate receiver *C*, and thus re-enters the closed circuit to the accumulator. Chilled water from the bottom of the evaporator is circulated by a chilled water pump *T*. This pump is controlled by the room thermostat *E*, thus maintaining a temperature within the dwelling approximately 15F below the outside air temperature. As the entire system is automatically controlled, after once being adjusted, it requires very little attention for operation.

With an accumulator system of this kind in a dwelling, advantage can be taken of the stored heat energy to provide sterilizing steam for use in the kitchen, as well as to provide a source of steam heat energy for pressure-cooking of food and for a steam table to maintain prepared food at a uniform temperature. This makes available to the occupant of a small dwelling all of the conveniences that now are installed in the most modern hotel and restaurant kitchens.

Low-Pressure Steam Installations

Fig. 3 shows the adaptability of the electrothermal heating system to existing dwellings having low-pressure steam heating installations.

The electrothermal heating unit can be used as the heat energy source for existing dwellings that have installations of low-pressure steam radiators *F* for heating. It is not considered

Fig. 7.
Accumulators, pressure-reducing equipment, and electrical control equipment

necessary to repeat the description of the various elements in the electrothermal heating system as these were described on page 73.

To adapt the electrothermal storage heating system to a low-pressure steam radiator installation, it is necessary only to connect the two lb per sq in. steam discharge header from the hot water accumulator to the main steam riser of the existing system. The main thermostat *E* will respond to the room temperature and regulate the steam flow through the modulating thermostat control valve *D*. By this method of control, the steam flow to the radiators varies with the demand for heat as indicated by the thermostat.

Condensate from radiators is returned through the common drain header back to the condensate receiver *C*, through the thermostatic trap *G*. Here again the system is a closed one, and the condensate is continually re-used with only slight make-up water being required. With this low-pressure steam heating system, no control is possible of relative humidity or air conditioning unless additional ventilating ducts and equipment are installed. The various uses to be made of the steam in the kitchen and for hot water heating remain as previously described.

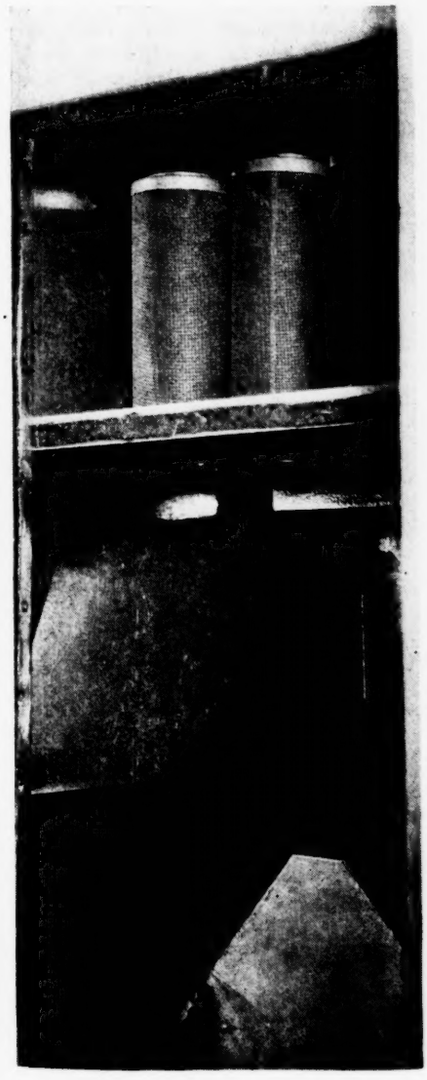

Fig. 8. Renewable dust filters and activated carbon filters in return air duct.

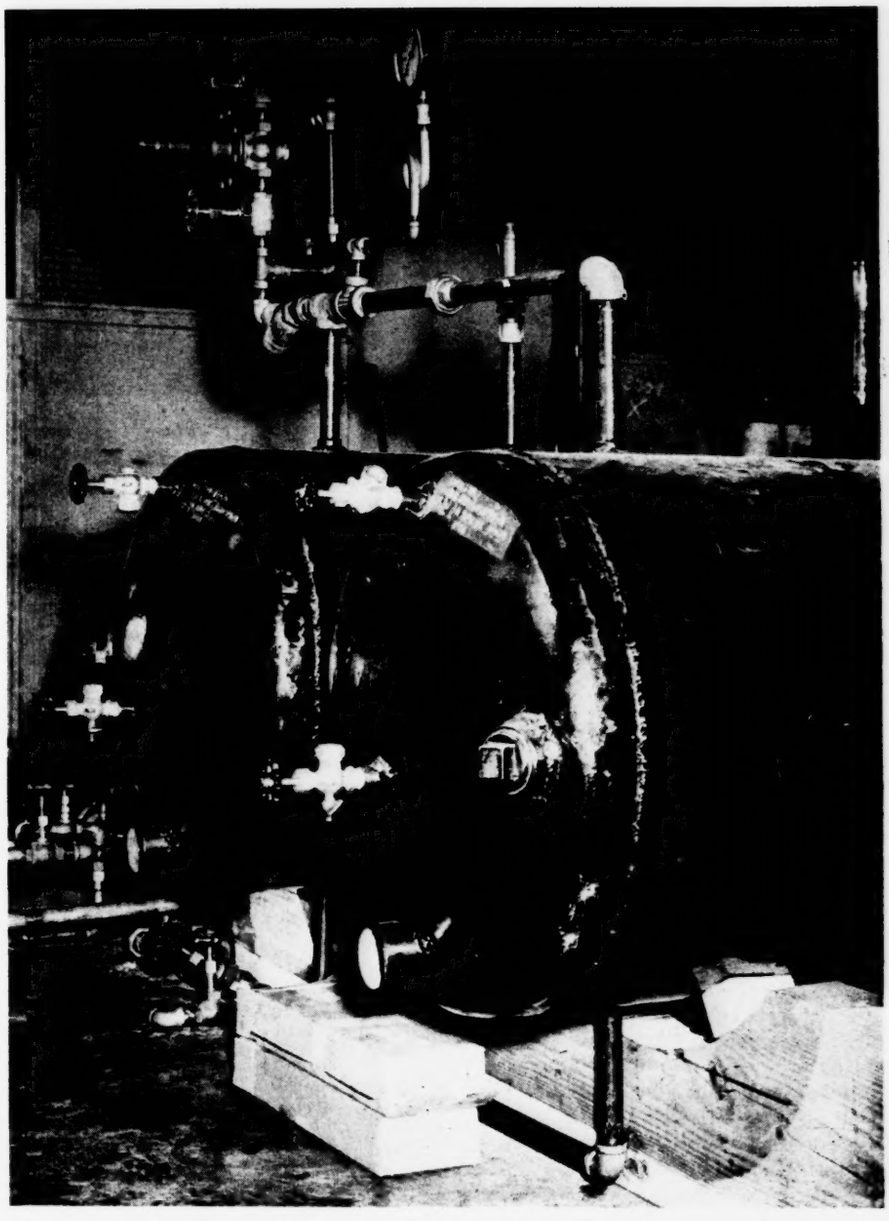

Fig. 9. Shop assembly of two 23½" diameter accumulator tanks.

Hot Water Heating

Two general types (Fig. 4) of hot water heating systems are installed in existing dwellings, namely, gravity systems and forced circulation systems. Use of the electrothermal off-peak accumulator system with either type is practically as simple as that used in the low-pressure steam radiator system.

In order to adapt the electrothermal accumulator system to hot water heating, it is necessary to provide only a small hot water tank fitted with an immersion steam coil. This coil functions as a heat transfer element to heat the water of the radiator system. The flow of steam to this immersion coil is controlled by the modulating thermostatic control valve *D*, which in turn is controlled by room thermostat *E*. Circulation in the gravity hot water system is com-

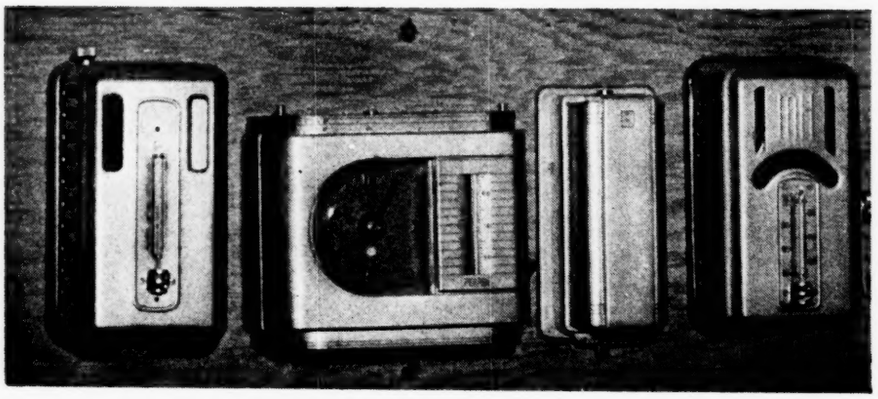

Fig. 10. Control instruments in living room. From left to right — summer thermostat, night set-back thermostat, humidistat, and winter thermostat.

paratively slow, which makes it difficult to maintain a uniform room temperature. If the hot water system is of the forced circulation type, a more even distribution of the water is obtained throughout the system and the water temperature can be governed more uniformly by the thermostat.

At the present time, considerable study is being given by engineers to the use of radiant heat installations in modern homes. In this type of heating, hot water coils are placed in the floors and/or in contact with the plastered ceilings. The electrothermal unit can very well be used as the source of stored heat energy in the same manner that it is used with a forced circulation hot water system described. The hot water heating systems do not provide any humidification or air conditioning. To obtain these features, it would be necessary to provide humidifying and ventilating equipment.

Midway Cottage Installation

An electrothermal off-peak heat storage and air conditioning system has recently been installed in a five-room cottage at the Midway Substation of the Bonneville Power Administration in Central Washington, Fig. 5.

The cottage has no basement. Therefore, to conserve space in the dwelling, the entire electrothermal and air conditioning unit was installed in the attic.

The cottage is well-constructed with insulated floors, side walls, and ceilings. All windows are tightly weatherstripped, and both front and back entrances are vestibuled with double doors. The design conditions at Midway are —5F outside and 70F inside, with a computed heat loss for the dwelling of 35,000 Btu per hour.

All heating equipment is housed in a small, well insulated room constructed in the attic. This room is easily reached through a hatch from the utility room on the first floor.

The electrical control board (Fig. 6) was placed on the outside wall of the small equipment room to make it accessible for testing purposes.

The cold air return duct system was installed under the floor, and the hot air ducts were placed over the ceiling joist. Hot air is distributed from the duct system through registers or grilles placed near the ceiling line, affording a very even method of distribution of air in the dwelling. In the overhead duct system, ducts are all rectangular in shape with angular bends. In all bends, curved blading is used to direct the air flow. This type of duct design reduced friction losses to a minimum. Air velocity measurements as taken by a velometer do not vary more than 10 fpm at any of the register outlets.

Two electrothermal hot water accumulators were used on this installation because all equipment installed in the attic of the cottage had to be small enough to pass through a 24 by 24 in. hatch. Arrangement of equipment in the room is compact yet accessible for maintenance purposes.

Hot water accumulators are insulated with 4½ in. of magnesia block and 4 in. of rock wool and then covered with duck which is pasted on.

The entire duct system is insulated with rock wool, which is wired on

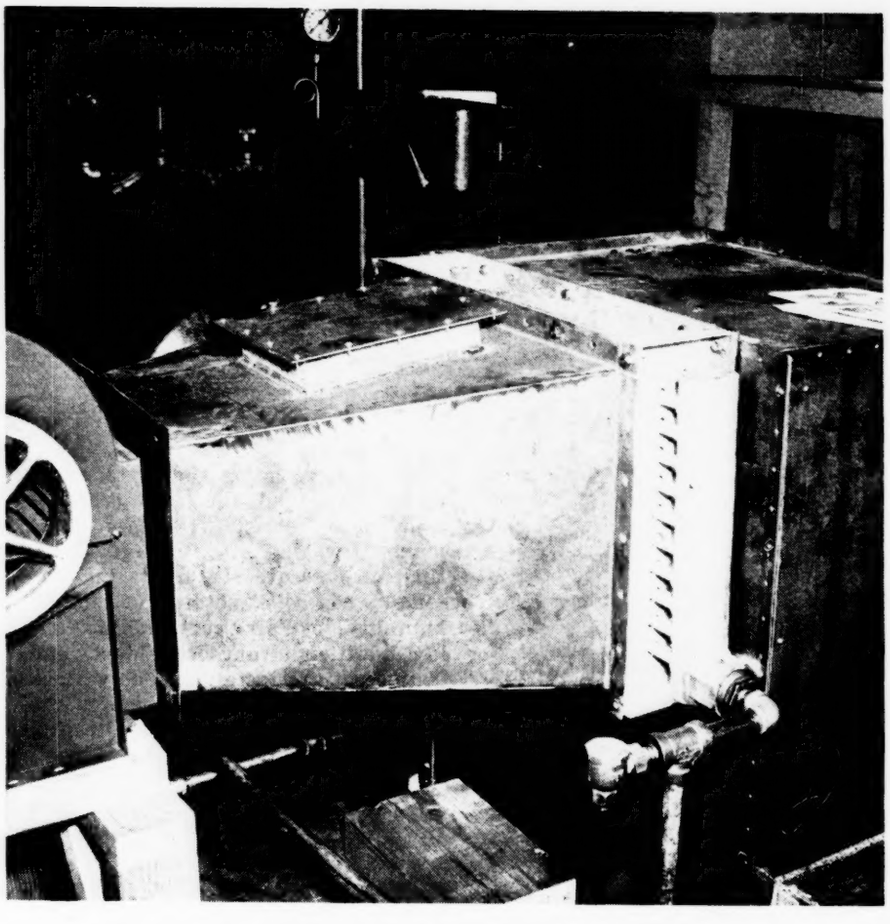

Fig. 11. Shop assembly of fin tube heater to plenum chamber.

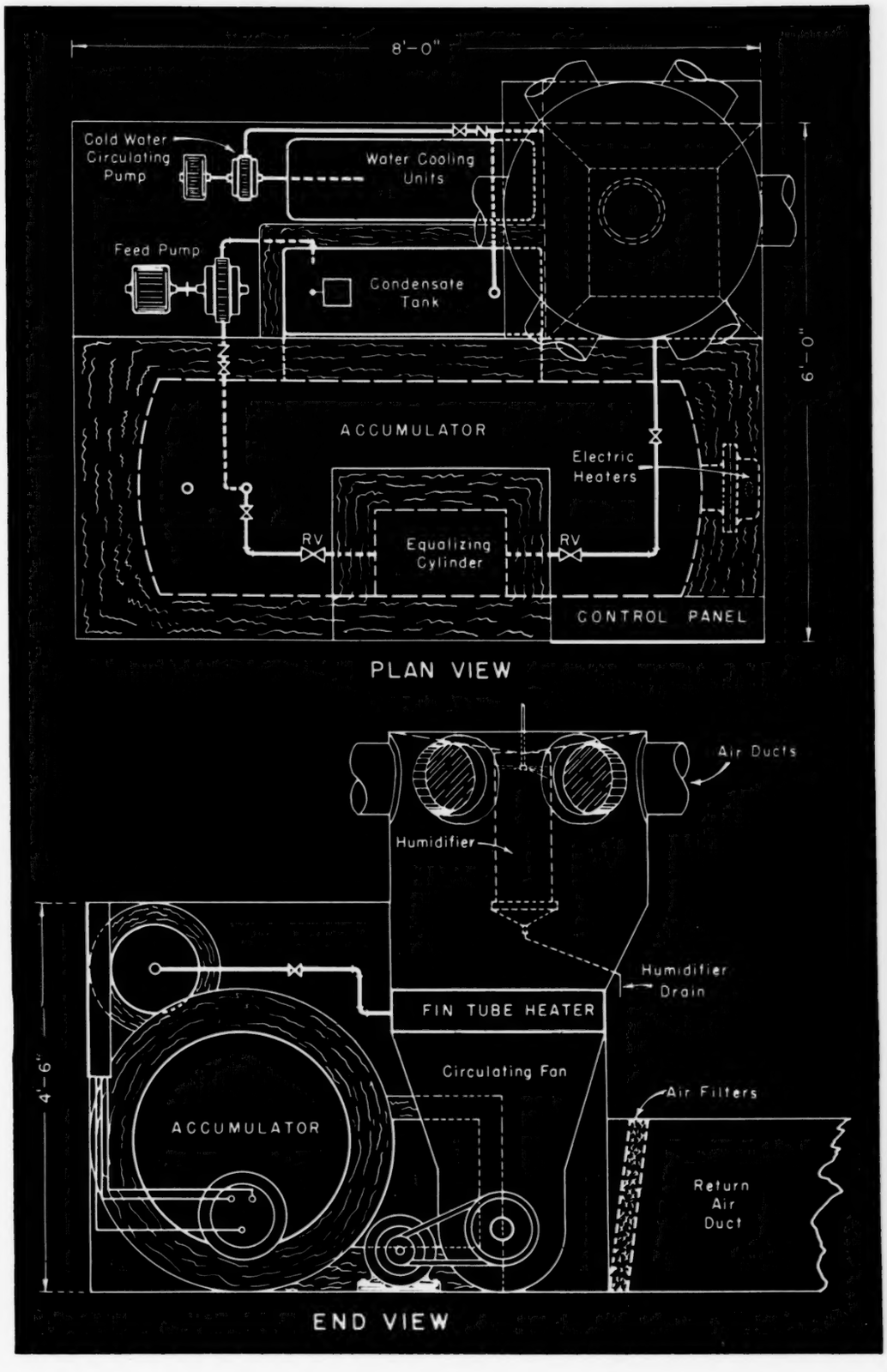

Fig. 12. **Electrothermal home heating, cooling, and air conditioning unit.**

and finished by covering with duck.

Fig. 7 shows the equipment installed inside the attic room.

Each of the two accumulators contains 105.5 gallons of water. At the normal operating condition, the accumulators have an effective heat storage capacity of 300,000 Btu, between 200 lb per sq in. and 5 lb per sq in.

The Midway installation incorporates all of the features discussed in connection with Fig. 2, with the exception of the refrigerating unit. This will be installed as soon as it is completed. Weather conditions have been too warm to obtain any scientific data on this heating system.

However, the fall heating season is just starting. Recording instruments have been installed to provide continuous records for inside and outside temperatures, relative humidity, electric energy consumption, pressures in accumulator, and air temperatures in the plenum chamber of the hot air duct system. These records will be available at a later date.

Conclusions

Electrothermal space heating and air conditioning is based on thermodynamic principles and is very simple. The equipment involved in the construction of the system is standard and can be supplied by existing manufacturers.

Heating and heat storage features can replace oil, coal, or wood burning equipment used in existing heating systems in dwellings such as hot air heating, Fig. 2; low-pressure and vapor steam heating, Fig. 3; and gravity or forced circulation hot water systems, Fig. 4. It is also possible to make use of the stored heat energy for sterilizers, pressure-cooking, and steam tables, giving the housewife all the advantages of the equipment in the modern hotel kitchen.

The system is practical and economical to install in any dwelling or building now existing or in new construction. It is estimated that the cost for converting a hot air heating system to the electrothermal storage heating system in a six-room dwelling would not exceed $600.

The electrothermal heat storage unit uses daily off-peak electric energy, thus using hydroelectric energy that would otherwise be wasted in stream flow plants.

This system is advantageous from the standpoint of the utilities, as it permits the use of their distribution systems at a much higher load factor than is now possible. It also offers the advantage that interruptions to the service for short periods of time, which are unavoidable, have no effect on the operation of the storage system.

The consumer derives advantages from the storage system by being assured of a continuous heat supply. He can take advantage of a high heat release to heat the dwelling quickly from night temperature conditions, thus assuring a comfortable home within a few minutes in the morning and also evening comfort after the dinner hour. Then there are advantages of cleanliness, elimination of all fire hazards, lower insurance rates, simplicity of operation, and minimum space requirements.

Studies indicate that the cost of the equipment installed in the dwelling is moderate and competitive with other first-class heating and air conditioning equipment on the market at the present time.

Acknowledgment

The author acknowledges the helpful suggestions given by H. R. Stevens, Chief of the Power Resources Section, Bonneville Power Administration, and B. W. Farnes, an independent consulting engineer. Diagrams are reproduced by permission of the American Institute of Electrical Engineers.

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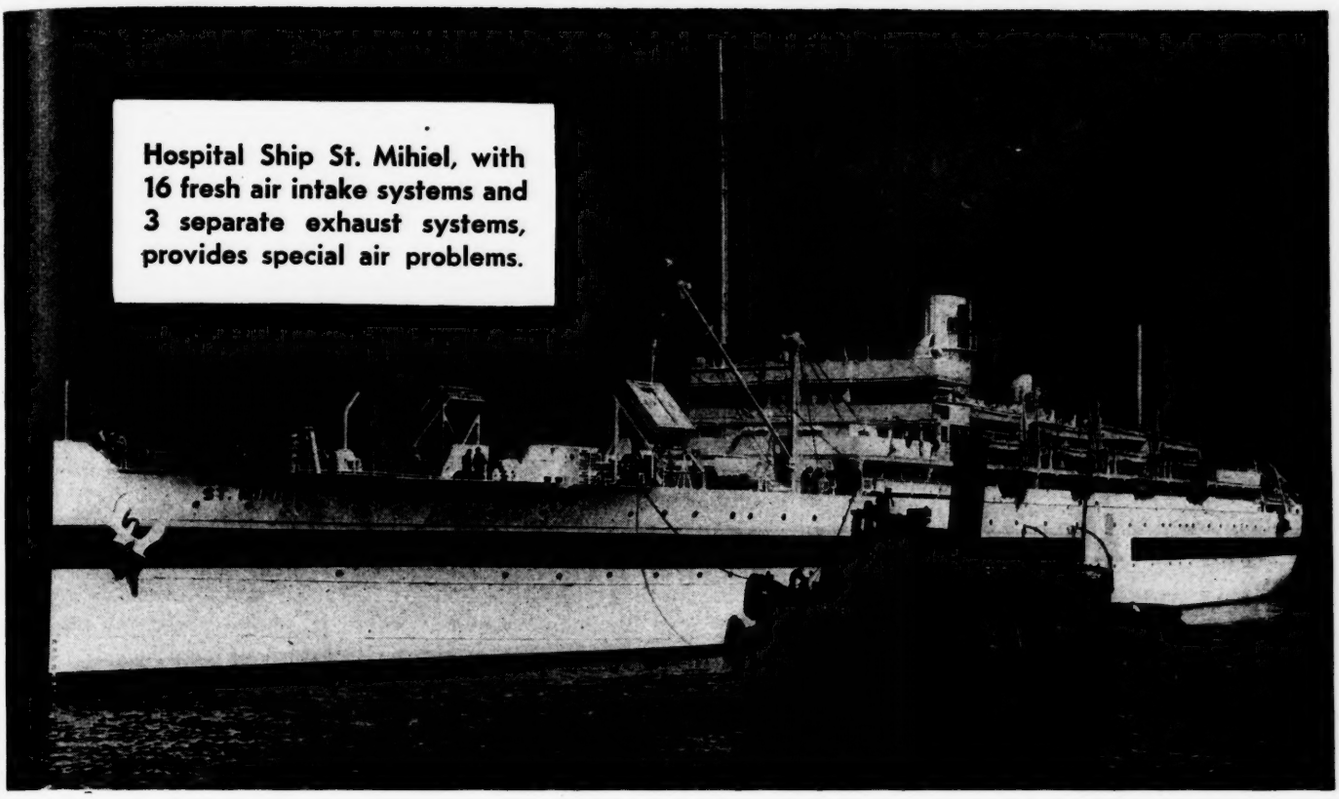


Hospital Ship St. Mihiel, with 16 fresh air intake systems and 3 separate exhaust systems, provides special air problems.

Transport Converted Into Hospital Ship

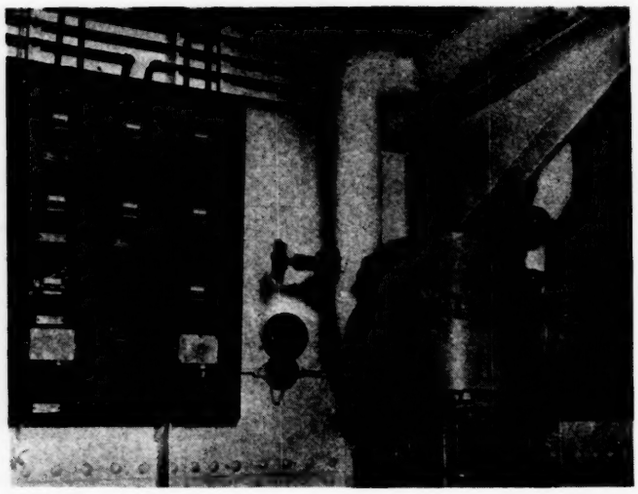
F. N. HOLLINGSWORTH

FOR the first time in this war, a United States Army Hospital ship, the St. Mihiel, newly converted from a former Army transport, was recently opened for public inspection at the Port of Boston. She is one of 18 hospital ships now in service, conveying American wounded from the war zones to the United States for detailed hospitalization and convalescence. Six more of the mercy ships will be added to the Army hospital fleet by the end of the year, the 24 having a total capacity of more than 14,000 patients, of whom about 3,500 will be walking wounded. This fleet is operated by the Transportation Corps, Army Service Forces. A sister ship is the Chateau Thierry, which went into commission previously.

The St. Mihiel has 16 separate fresh air intake systems and three separate exhaust systems, with provision for heat tempering of the indrawn air as required. Main purpose of the ventilation systems is to regulate the volume of clean air in each ward and in other parts of the ship, with a certain amount calculated for each room. These calculations are principally based on the number of persons in each ward or room. Exhaust systems are planned to thoroughly rid the area of foul air throughout the ship at predetermined intervals. Glass fiber filters are used only for the operating rooms and there mainly because, when lying in port, the entering air might be dust laden or otherwise contaminated. For other parts of the ship, since the fresh air will be mainly indrawn at sea, the air is presumed to be clean and pure.

Separate supply systems were installed because of different requirements for different wards and other rooms and to obviate, as far as possible, cutting through bulkheads. In those cases, valves were installed so that apertures could quickly be shut off to watertightness and a break confined to one compartment in case of damage.

Air is brought in through cowls at different levels, to accommodate each deck separately, with heating coils for tempering the air as needed in various locations, at the intake side of the blowers and others on the discharge side. But in all cases the cowls are big enough for a proper supply of warm air, which ranges in volume from 1,200 cfm on the smaller systems to 13,350 on the larger ones. In addition each room is provided with one or more radiators attached to the auxiliary steam system to provide extra heat if needed, or in case of failure of the regular ventilating system. Grand total of air volume for all sections supplied is 100,000 cfm. Average temperature at the grilles is 70F, but this may be raised by opening the radiator valves.



A gauge board installation for one of the compressors.

Fans for supply and exhaust were procured under Army priorities. They are enclosed in regular housings, except that the housings for those on deck are specially built. Deck houses have small separate fans for ventilation, and the regular radiators for heating.

Where advisable, fins were placed to regulate the air flow, to balance the system, eliminate noises at sharp bends and to increase the general efficiency. The ship's galleys are cooled by exhausting the excess heat through hoods over the steam kettles and ranges, leading to the exhaust systems.

All ducts are located in the ceilings and split to starboard and port sides of the ship. All are of sheet metal, with an approximate total of 6,000 ft, the longest being 442 ft for the main or B deck. They have adjustable deflectors to control the air movement and those in the X-ray operating room and adjacent X-ray darkrooms are lined with lead.

The heating coils also take care of excess humidity, which might be encountered in a fog or steamy atmosphere. There is no re-circulation and the returns are practically opposite the supply, with grilles, in some cases just above the floor, while all are placed to avoid drafts over the patients. Special adjustments are possible, where the main duct on each deck splits the starboard and port. In some cases these adjustable fins are close to the grilles, while the grilles themselves can be adjusted by the engineers to cut noise and regulate airflow into the rooms. Grilles are mainly square or rectangular, ranging in size from 4 x 4 in. to 10 x 16 in.

Deck houses have separate fans and louvers for discharge of foul air. The engine room has a separate fan, with natural exhaust through separate cowls. Mental patient areas have barred grilles, set flush.

Medical Facilities

There are two operating rooms, a dental surgery, X-ray room and connecting darkroom, a surgical ward with diet kitchen, medical and other surgical wards, such as orthopedic and septic, dressing stations, pharmacy, administrative offices, Red Cross office, officers' and nurses' quarters, sales commissary, and enlisted men's quarters and lounge. In addition there is a large main galley and four separate galleys connecting through swing doors to wards, all supplied with the best equipment for preparing foods and special diets and providing quick service.

The main operating ward has two grilles, supplying about 300 cfm each and two exhausts, each of the latter handling 150 cfm. The laboratories have one grille each, handling 200 cfm, and a return. On either side of the officers' lounge is a supply duct, each designed for 200 cfm with returns, while the staterooms (nurses to starboard and engineers, etc., to port), the enlisted men's and crew's quarters are fully ventilated.

Fan motors range from 1 hp to 10 hp, at variable speeds with field rheostats. Some toilets have exhausts only, while others also have a fresh air supply. All exposed metal of the supply systems was covered with an application of zinc chromate before painting.

Work of conversion was done at the East Boston Simpson Yards of the Bethlehem Steel Corporation's Shipbuilding Company, under supervision of the Boston Port of Embarkation, according to specifications worked out jointly by the Army Transportation Corps and the Surgeon General. Bethlehem engineers developed plans and blueprints from Army line drawings and had immediate charge of alterations.

The ship had practically to be torn out inside completely, from the keel up, and rebuilt. A large area of superstructure was built at the bow and at the stern, thus adding an extra deck. A deckhouse, fore and aft, was also built. A new evaporation system to provide fresh water during the voyage was installed and magnificent laundries equipped with ventilation supply and exhaust system. In fact the new construction was equal to the load of installations of a big hotel.

Before sailing each system had a minute test and all grilles were tested to see that each delivered the proper amount of air. The lighting system was built in, with circular units, and all parts of the ship have circular type fire thermostats.

The St. Mihiel is 437 ft long with 58 ft beam, and has an 8,000 gross tonnage. She accommodates 515 patients, as compared with a capacity of 1,117 persons when she was operated as a troop transport. She was built in 1920 at an original cost of $3,500,000 and converted to a hospital ship at an additional $2,000,000 expenditure.

There are 15 Medical Corps officers, 34 nurses, one Red Cross worker, one dietitian and 135 enlisted men of the hospital staff. The civilian merchant crew, employed by the Transportation Corps, Army Service Forces, numbers 123 men. All Army personnel, including patients, are under command of the Senior Medical Officer, who is also hospital ship commander.

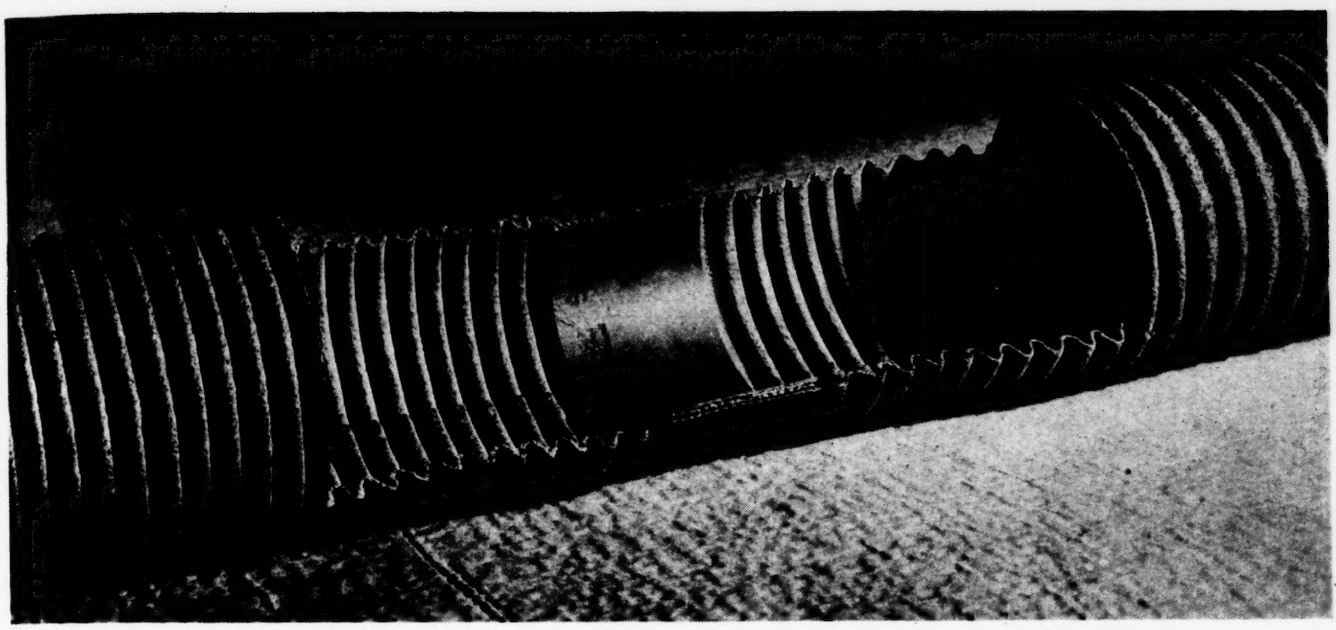


Fig. 1. Section of the tubing cut away to show how two lengths are joined.

Flexible Ducts Made from Fabrics

ONE result of the rapid and exciting developments in the airplane industry is a new product that has large scale applications in the heating, ventilating and air conditioning fields. It is a circumferentially corrugated duct, flexible, and unsupported by any wire. It is made from asbestos, glass or cotton fabrics, coated on the inside with a very thin layer of synthetic rubber, and on the outside by a coat of stiffening resin.

Made by a patented process, the Multi-Flex ducts are now being used on military and cargo carrying aircraft for heating, ventilating, defrosting and deicing systems. It is being presented in this series of articles because of its potential possibilities in the industrial fields of heating, ventilating and air conditioning.

At present the entire output is going to the armed forces and none will be available for civilian markets until such production is authorized by the government.

The tube is made in various sizes from 1 to 15 in. diameters or equivalent cross sectional area in oval

Fig. 2. A wide variety of shapes can be formed from this material for duct fittings.

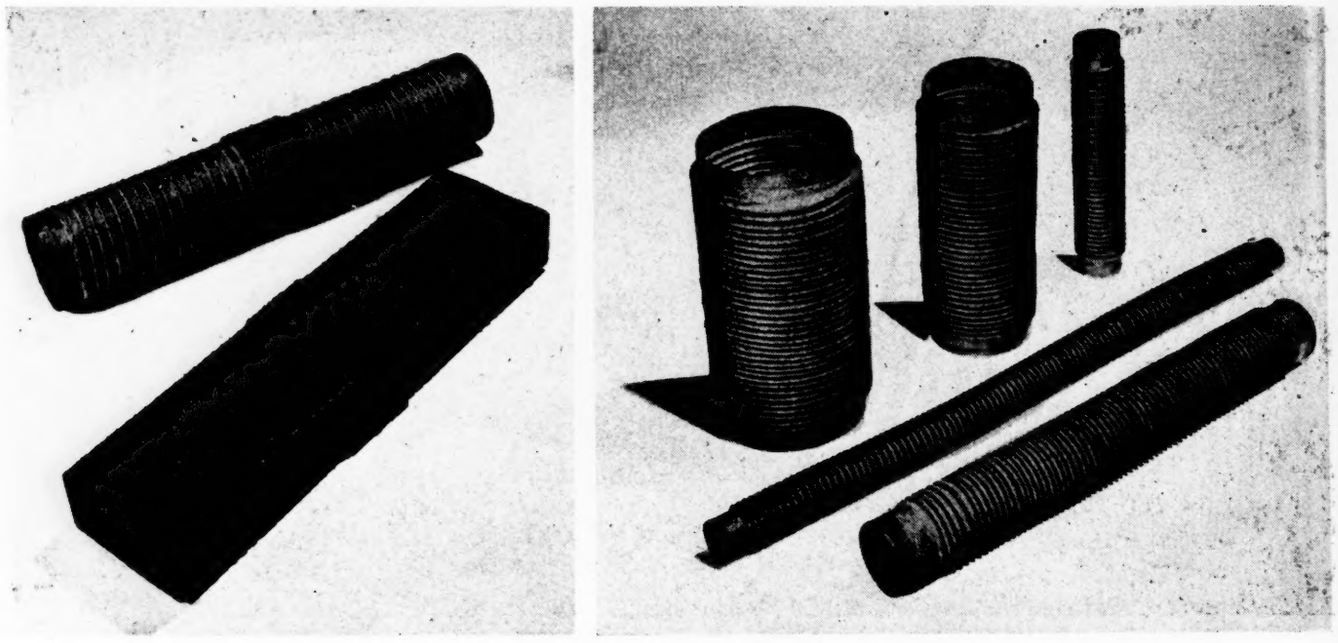


Fig. 3. Left (top) duct style X-1942 and bottom, X-1904; right, X-1803.

or rectangular sections. It can be fabricated in any special shape desired. Continuous pieces may be made which are a combination of corrugated and straight sections although the lengths of the sections are limited to 10 feet.

Because of its flexibility, it is possible to install a duct to an existing system and to make alterations without extensive ripping of floors and walls. The tube can be run around existing piping and beams. For new work, it is no longer necessary to follow the straight lines dictated by rigid ducts.

In general, the duct is made from an asbestos fabric but for special needs not met by the regular type, glass fabric is used. While a Multi-Flex duct

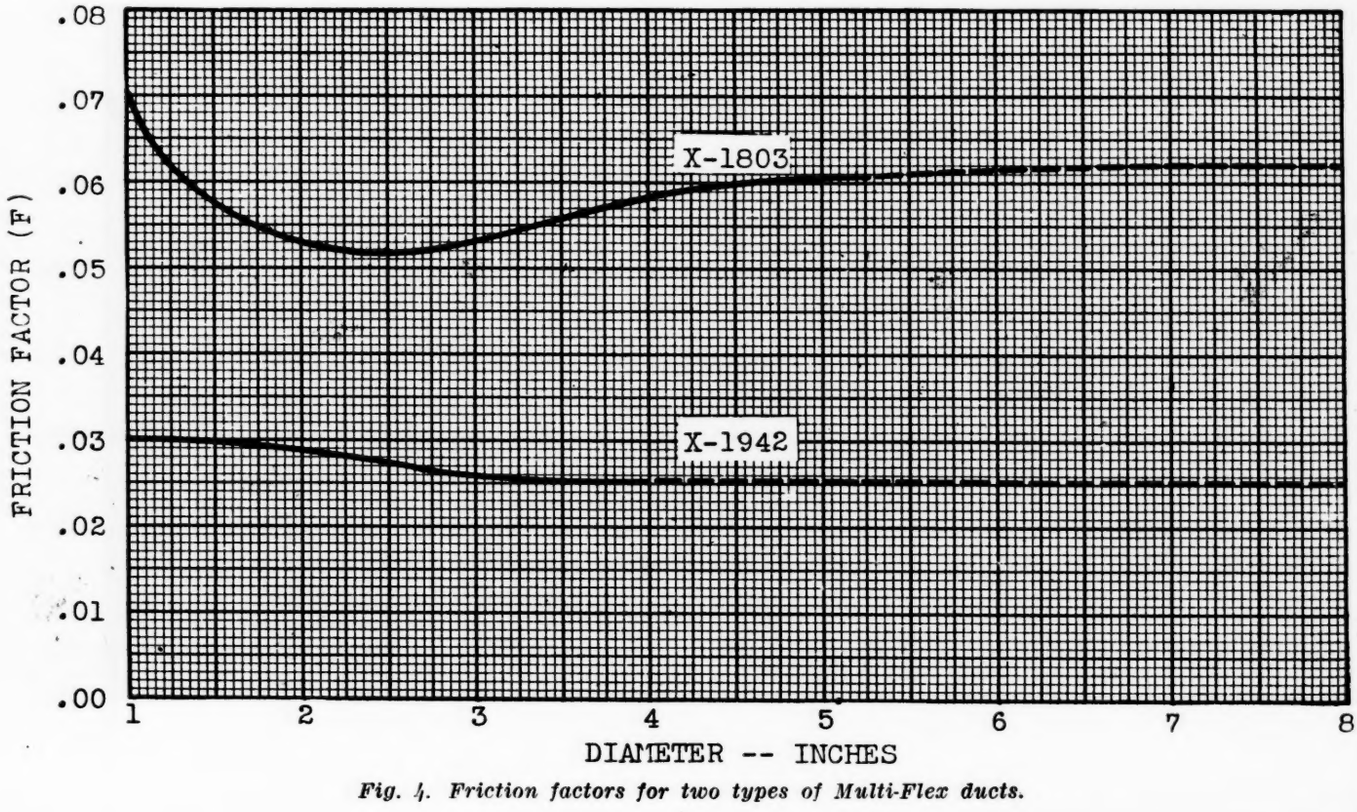


Fig. 4. Friction factors for two types of Multi-Flex ducts.

has a fair resistance to abrasive-laden air, if required, changes can be made to provide a high abrasive resistance. The material will withstand fumes such as almost any organic solvents and acids. In addition, it is fire-resisting and dampproof.

Ducts can be used for temperatures up to 350F maximum and can withstand pressures varying from 20 lb per sq in for 1 in. diameter ducts to 5 lb per sq in for ducts 15 in. diameter. It has sufficient body to permit use as suction lines. Slight modifications in processing are desirable for ducts used in some external pressure applications.

No metal is required even for such customary fittings as tees and elbows. The same coated fabric is shaped over forms to produce standard type fittings. The same process is used for making transition pieces for connecting, say, ducts of round cross section to ones of square or oblong cross section. Y's, and special shapes usually found in metal duct lines, can be fabricated. Fittings and ducts are much lighter than equivalent sheet metal parts.

A simple means is provided for joining duct lengths and fittings, as illustrated in Fig. 1. A plastic sleeve is inserted in the ends and a strip of adhesive fabric is wrapped around the outside to hold the joint intact.

Friction losses for two types of Multi-Flex ducts can be obtained from the charts. To obtain the pressure drop *P* in inches of water for these two types of ducts, the following formula is used:

$$P = 0.0027\ F\ L\ S\ \frac{V^2}{D}$$

P = pressure drop in inches of water
L = length of duct in feet
D = diameter of duct in inches
S = specific gravity of air (referred to standard air at 0.075 lb per cu ft)
F = friction factor

ELBOW LOSSES—TYPE X-1803 SHORT-RADIUS 90-DEGREE BENDS

Diameter Duct, Inches	Centerline Radius of Bend, Inches	Net Elbow Loss		
		Velocity Heads	Equivalent Diameters	Equivalent Length—Feet
1	5	0.00	0	0.0
2	5	0.75	13	1.1
4	8	0.90	14	4.6

The table lists the elbow losses for type X-1803 short radius 90 deg. bends. Elbow loss in terms of velocity head is approximately constant at all air velocities to 10,000 fpm. For a centerline radius of bend equal to twice the radii in the table, one-half of the values given are to be used. Computations for an entire length of duct, including length of bends, is made separately and then the net elbow losses for the bends are added.

In applications where it is important to have a flexible duct, the material described may become an important engineering tool for industrial applications.

Data and illustrations for this article were supplied by the United States Rubber Company, makers of this new duct.

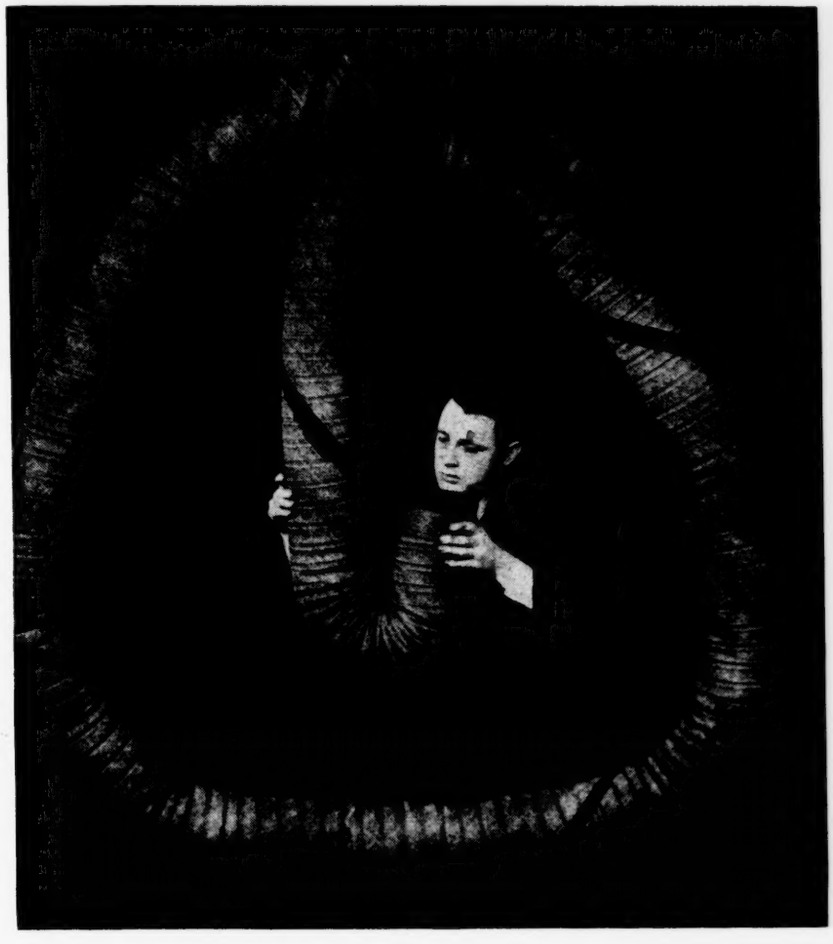
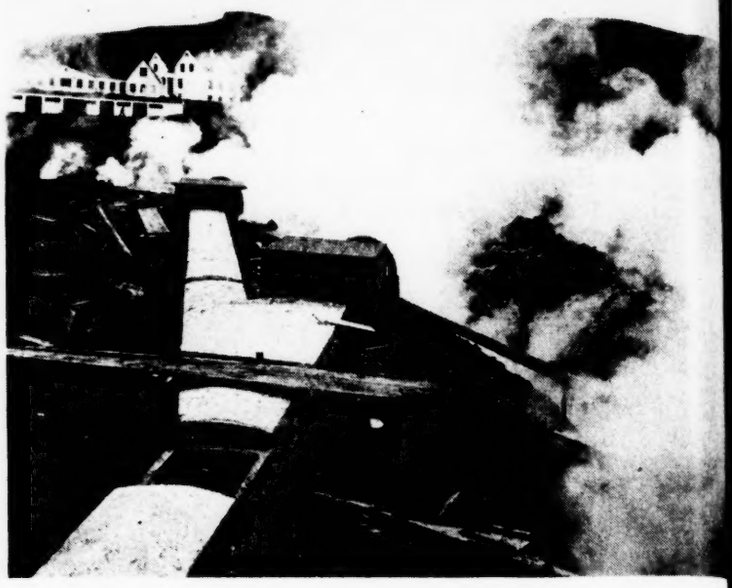


Fig. 5. This duct, which has been twisted to show its flexibility, has an inside diameter of 6 in.

Central Heat for Iceland

A brief record of novel developments

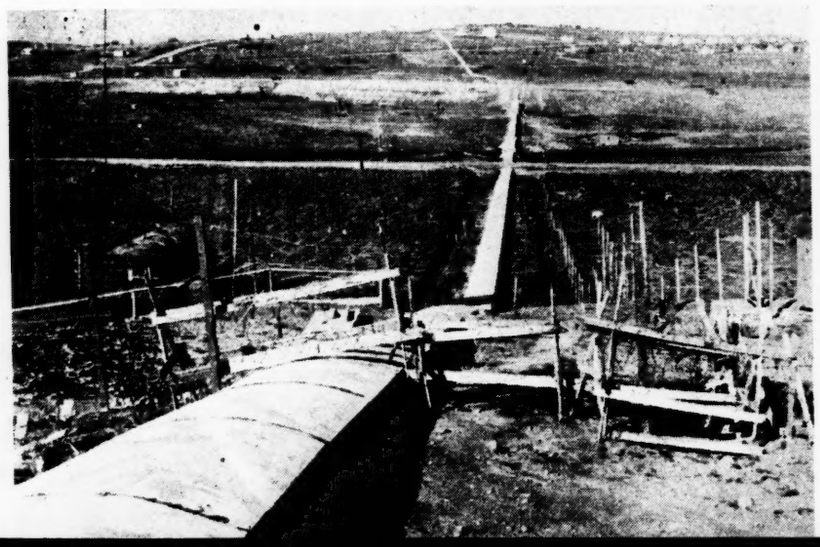


Natural hot springs, about ten miles from Reykjavik, Iceland, were piped to homes in the city. Steam is always present at the springs where the water temperature is about 170F.

This may have been more interesting than school books. In order to rush the completion of the pipe lines before the brief summer was over, school boys on vacation from school helped to dig the necessary trenches. Pipe and fittings were supplied by American manufacturers. Mains are 16 in. and smaller. It is possible that after the economics of this system are studied, hot springs in other countries may be similarly employed.

Because of the large temperature differential between the water in the pipes and the surrounding earth, during the cold season, pipe insulation is important. Dried turf is placed around the pipe and wire netting is bound around the turf to hold it in place.

Part of the completed section of the main pipe line to carry heat from the hot springs to homes served by this novel central heating system. With this system, the Iceland city does not have to worry about fuel difficulties, nor the problems of dwindling manpower faced in this country.



Zoning of Heating Systems for Post-War Comfort and Fuel Economy

T. W. REYNOLDS

ONE of the questions frequently asked the heating engineer relates in one form or another to what kind of heating system is best for residences. As the years go by it finally dawns on the engineer that heating systems as now known are not fully satisfactory or the question would not exist.

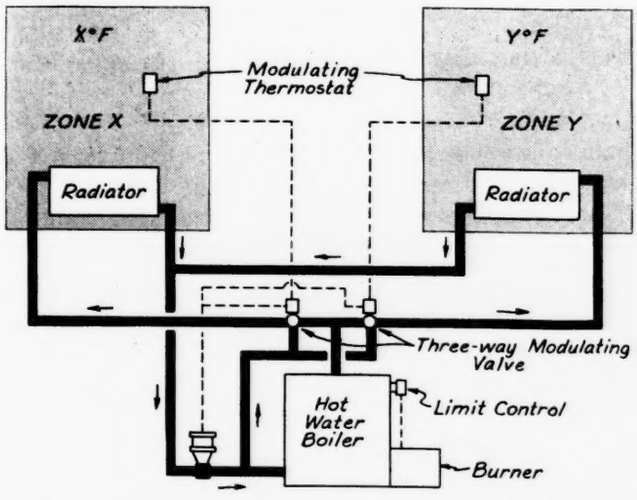


Fig. 1. Schematic diagram showing modulated and sectionalized control for a hot water heating system.

For years we have been trying to heat the house with one thermostat on one wall of one room at a uniform setting with an off-and-on control, storing up heat when on to be used when off, as opposed to a constant distribution of heat only to the extent that replacement is required. Failures in the past to provide continuous heat distribution has resulted in first a lag, then an overshoot, high fuel bills, and a house too chilly when the thermostat shuts off.

The temperature gradient throughout each room of the house should be maintained as nearly uniform as possible so that there will be a minimum temperature differential between floor and ceiling. Present day systems maintain this differential at a minimum during firing periods, but during off periods cold air settles to the floor and uncomfortable conditions prevail even though the thermostat is satisfied.

To correct this condition, a constant flow of heat should be maintained which will produce a constant flow of warm air circulation in each room. The writer, in his own home, is often warmer in the morning after a night set back on the thermostat with the house at 60F and the burner operating at maximum, than he is later in the day with the burner off and the temperature in the house at 70F. As long as the air is warm and in motion conditions are satisfactory.

Another failure of residential heating systems has been lack of some method to assure even heat throughout the house. Sometimes the living room has to be overheated to get the rest of the house warm, or the ceilings are hot, walls and floors cold, bed rooms and bath rooms cold, kitchen too hot when cooking, and the sunny side of the house too warm while the windward side is too cold.

Rooms Have Individual Needs

To a certain extent each room of a house requires a different quantity of heat at different times; such spaces as the garage, recreation room, laundry, kitchen, nursery, sick room, bath room, bed rooms and living rooms—each has its individual requirements. However, if the typical house is sectionalized for control into two or three natural divisions (dependent upon its size), there will be sufficient satisfaction as to heating. These natural divisions are (1) service section (kitchen and laundry), (2) living room and dining room section, and (3) sleeping section. By this method each section of the house will have in effect its own separate heating system operated in

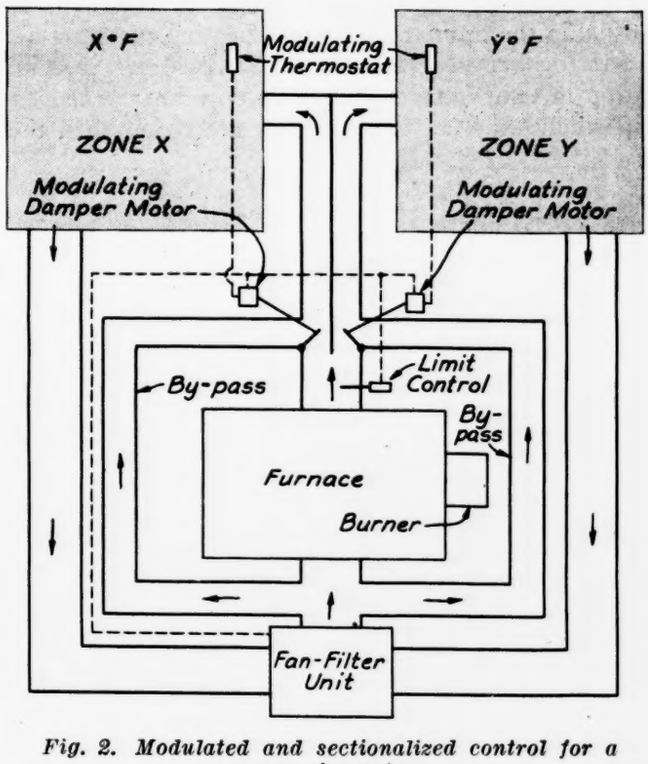


Fig. 2. Modulated and sectionalized control for a warm air system.

accord with the varying requirements of the section.

It seems to the writer that the new modulated flow and sectionalized control systems as proposed for the post-war period for hot water, steam, or warm air residential heating systems will go a long way towards settling many of the grievances of the past. The sketches accompanying this article are illustrative of the general idea, the house being modulated and sectionalized into two divisions as shown, or sectionalized into as many sections as desired. Such a system may even be modulated as a whole as though it were a single section, as may be sufficient in a very small house or as possibly made necessary for easy adaptation to an existing house.

Methods of Modulation

In Figs. 1 and 2 modulation is obtained by bypassing the hot water boiler and the warm air furnace, so as to provide a continuous circulation of water or air and a mixture with the hotter fluid from the heater as required. In Fig. 3 modulation is obtained by modulating steam valves and orifices at the radiators. The thermostats control the steam valves so as to admit steam to the radiators in the amount they require. Pressure is maintained on the boiler. In each sketch one section of the house may be maintained warmer or cooler than the other, as desired.

In Fig. 1 showing the hot water heating system, as each thermostat calls for heat, it operates a three-way mixing valve to admit hot water, cooler return water from the radiators, or a combination of both in a mixture of the temperature demanded by the radiators. The boiler provides a constant reservoir of heat, and circulation is continuous as long as heating is required. There is no lag or overshoot as usual in the ordinary hot water heating system.

If the hot water system is designed for a small drop in temperature between supply and return, or if widely different temperatures are required in the various sections, a separate circulator may be required in the various sections; otherwise the return water from one section may overheat another section. In some cases, however, the need for a separate circulator may be eliminated by installing balancing cocks in each section so as to increase the temperature drop between the supply and return.

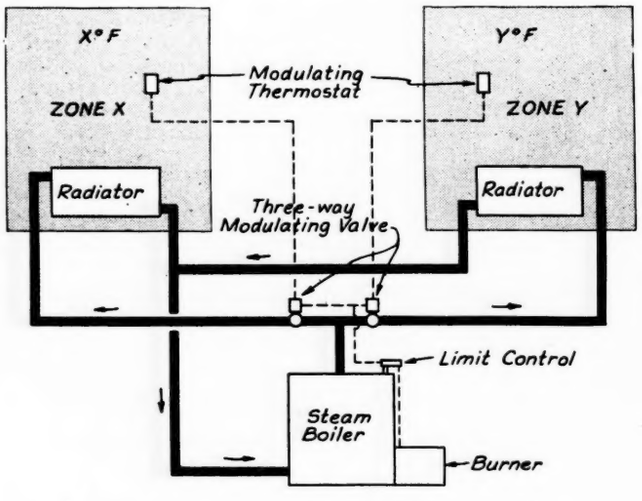


Fig. 3. Modulated and sectionalized control for a steam heating system.

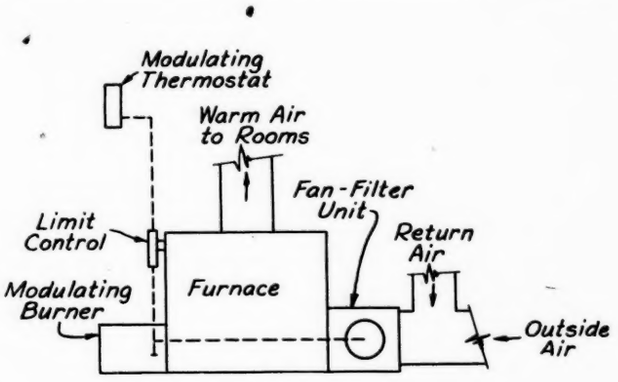


Fig. 4. One method of modulating a warm air system.

In Fig. 2 showing the warm air heating system, as each thermostat calls for heat a damper motor is actuated to operate the modulating damper, mixing warm air from the furnace, the cooler return air, or a combination of both. A mixture of return air with outside air may also be desirable; in any event the method offers the advantages of pressure offsetting the usual drafts at doors and windows and attendant infiltration of dust.

Air Circulation

Circulation of air is constant unless there is no demand for heat, but the temperature of the air leaving the air outlets must be varied from the minimum allowable without drafts up to a maximum required for extreme weather conditions. This may be done in various ways, one of which is shown in Fig. 4. In this case the burner is of the modulating type and is modulated by the room thermostat so that the air temperature at the bonnet and at the outlets varies throughout the complete range of temperatures desired, and the fan runs constantly when heating of the space is required. The burner must not be throttled too much and excessive condensation must be guarded against. When a by-pass is used, as shown in Fig. 2, the furnace must be one which will not overheat a furnace section when air volumes are reduced.

In the final analysis a definite economy, aside from comfort, should result from modulated and sectionalized heating systems in residences, due to the lack of temperature fluctuations, and the saving of heat which would normally be supplied to an occupied section. The usual overheating of one section of an ordinary heating system can in the sectionalized system be utilized in some other section which by other methods was underheated.

Graphical Determination of Heat Transfer Film Coefficient for Ammonia

B. F. RABER* and F. W. HUTCHINSON**

THIS article continues the series started last month.[1] Based on the theory presented in the previous article, graphical solutions are given for the coefficients of heat transfer through liquid ammonia films inside and outside of a pipe. The problem of evaluating over-all heat transfer rates is then discussed and equations are developed for calculating the fluid-to-fluid heat transfer rate per lineal foot of pipe. These equations are then simplified to a form that includes three unit resistances which can be determined directly from a table. Based on this latter method the complete practical problem of evaluating fluid-to-fluid transfer across a pipe can now be solved by the following simple procedure:

1. Refer to the graphical solution of the film coefficient for the fluid inside the pipe (water was covered last month, ammonia is treated in this article, and others will appear in following articles). Enter at velocity, rise to inside diameter, follow directrix lines to horizontal scale, rise to temperature, follow directrix lines back to scale where read the inside film coefficient, h_i.

2. If standard pipe, enter Table 1 at value of h_i as determined above and read r_i in column under correct nominal pipe size. (If copper, brass, extra heavy pipe, or copper tubing, refer to similar tables which will appear in later articles.)

3. By same procedure as in (1) and (2), obtain r_o from Table 1.

4. Read r_p from Table 1 under the nominal pipe size.

5. Add r_i, r_o, r_p and divide into the fluid-to-fluid temperature difference to obtain the answer as a heat transfer rate expressed in Btu per hr per lineal foot of pipe.

Film Coefficients for Ammonia

The two charts for liquid ammonia are constructed from the equations discussed in last month's article and they are used in exactly the same way as those for water which have already been published.

Example: Liquid ammonia at 75F is being heated while flowing at 3 feet per second in a ¼" I.D. pipe. Following the dashed line on Fig. 3 gives $h_i = 1450$.

Example: Liquid ammonia at 100F is flowing outside and normal to a 3 in. O.D. pipe at a flow rate of 5 feet per second. Following the dashed line on Fig. 4 gives $h_o = 950$; this value is equally applicable whether the fluid is heating or cooling.

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**Associate Professor of Mechanical Engineering, University of California, Berkeley, Calif.

[1]See "Graphical Determination of Heat Transfer Film Coefficient for Water," HEATING AND VENTILATING, December, 1944.

TABLE 1.—THERMAL RESISTANCES PER LINEAL FOOT OF STANDARD WEIGHT PIPE
(ASA SCHEDULE 40-B-36-10)

(R_i = Inside film resistance; R_p = pipe wall resistance; R_o = outside film resistance; h = film coefficient of heat transfer from charts)

	Pipe Diameter, Inches																			
	¼		½		¾		1		1½		2		2½		3		3½		4	
Steel	r_p = .00238		r_p = .00183		r_p = .00147		r_p = .00138		r_p = .00101		r_p = .000848		r_p = .000930		r_p = .000804		r_p = .000733		r_p = .000681	
W. I.	r_p = .00178		r_p = .00137		r_p = .00110		r_p = .00103		r_p = .000755		r_p = .000634		r_p = .000695		r_p = .000601		r_p = .000548		r_p = .000509	
h	r_i	r_o	r_i	r_o	r_i	r_o	r_i	r_o	r_i	r_o	r_i	r_o	r_i	r_o	r_i	r_o	r_i	r_o	r_i	r_o
50	.209	.1415	.123	.0910	.0928	.0727	.0728	.0581	.0475	.0402	.0369	.0322	.0309	.0266	.0249	.0218	.0215	.0191	.0190	.0170
100	.105	.0707	.0614	.0455	.0463	.0364	.0364	.0290	.0237	.0201	.0185	.0161	.0155	.0133	.0124	.0109	.0108	.00954	.00948	.00848
200	.0525	.0354	.0307	.0227	.0232	.0182	.0182	.0145	.0119	.0100	.00923	.00804	.00773	.00664	.00623	.00546	.00538	.00477	.00474	.00424
300	.0350	.0236	.0205	.0152	.0154	.0121	.0121	.00968	.00790	.00670	.00616	.00537	.00516	.00443	.00415	.00364	.00359	.00318	.00316	.00283
400	.0263	.0177	.0154	.0114	.0116	.00909	.00910	.00725	.00593	.00503	.00462	.00402	.00387	.00334	.00312	.00273	.00269	.00239	.00237	.00212
500	.0210	.0141	.0123	.00909	.00928	.00727	.00728	.00581	.00475	.00402	.00369	.00322	.00309	.00266	.00249	.00218	.00215	.00191	.00190	.00170
600	.0175	.0118	.0102	.00758	.00773	.00606	.00607	.00484	.00395	.00335	.00308	.00268	.00258	.00221	.00207	.00182	.00179	.00159	.00158	.00141
700	.0150	.0101	.00878	.00650	.00662	.00519	.00519	.00415	.00339	.00287	.00264	.00230	.00221	.00190	.00178	.00156	.00154	.00136	.00135	.00121
800	.0131	.00884	.00768	.00568	.00580	.00455	.00456	.00363	.00297	.00251	.00231	.00201	.00193	.00166	.00156	.00136	.00134	.00119	.00118	.00106
900	.0116	.00786	.00682	.00505	.00515	.00404	.00404	.00323	.00264	.00223	.00205	.00179	.00172	.00148	.00139	.00121	.00120	.00106	.00105	.000942
1000	.0105	.00707	.00614	.00455	.00463	.00364	.00364	.00290	.00237	.00201	.00185	.00161	.00155	.00133	.00124	.00109	.00108	.000954	.000948	.000848
1100	.00954	.00643	.00558	.00414	.00421	.00331	.00332	.00264	.00215	.00183	.00168	.00146	.00141	.00121	.00113	.000992	.000978	.000868	.000862	.000771
1200	.00875	.00590	.00512	.00379	.00386	.00303	.00304	.00242	.00198	.00168	.00154	.00134	.00129	.00111	.00104	.000909	.000896	.000795	.000790	.000707
1300	.00807	.00544	.00472	.00350	.00356	.00279	.00280	.00223	.00182	.00155	.00142	.00124	.00119	.00102	.000958	.000839	.000827	.000734	.000729	.000652
1400	.00750	.00505	.00439	.00324	.00331	.00260	.00261	.00207	.00169	.00144	.00132	.00115	.00111	.000949	.000889	.000779	.000768	.000682	.000676	.000606
1500	.00700	.00472	.00409	.00303	.00309	.00242	.00243	.00193	.00158	.00134	.00123	.00107	.00103	.000886	.000830	.000727	.000718	.000636	.000632	.000565
1600	.00656	.00442	.00384	.00284	.00289	.00227	.00228	.00181	.00148	.00126	.00115	.00101	.000967	.000830	.000778	.000682	.000673	.000596	.000592	.000530
1700	.00618	.00416	.00361	.00267	.00273	.00214	.00214	.00171	.00139	.00118	.00109	.000943	.000910	.000781	.000742	.000641	.000633	.000561	.000558	.000499
1800	.00583	.00393	.00341	.00253	.00257	.00202	.00202	.00161	.00132	.00112	.00103	.000894	.000859	.000737	.000692	.000606	.000598	.000530	.000526	.000472
1900	.00553	.00372	.00323	.00239	.00244	.00191	.00191	.00153	.00125	.00116	.000972	.000846	.000814	.000699	.000655	.000574	.000568	.000502	.000499	.000446
2000	.00525	.00354	.00307	.00227	.00232	.00182	.00182	.00145	.00119	.00100	.000923	.000804	.000773	.000664	.000622	.000546	.000538	.000477	.000474	.000424

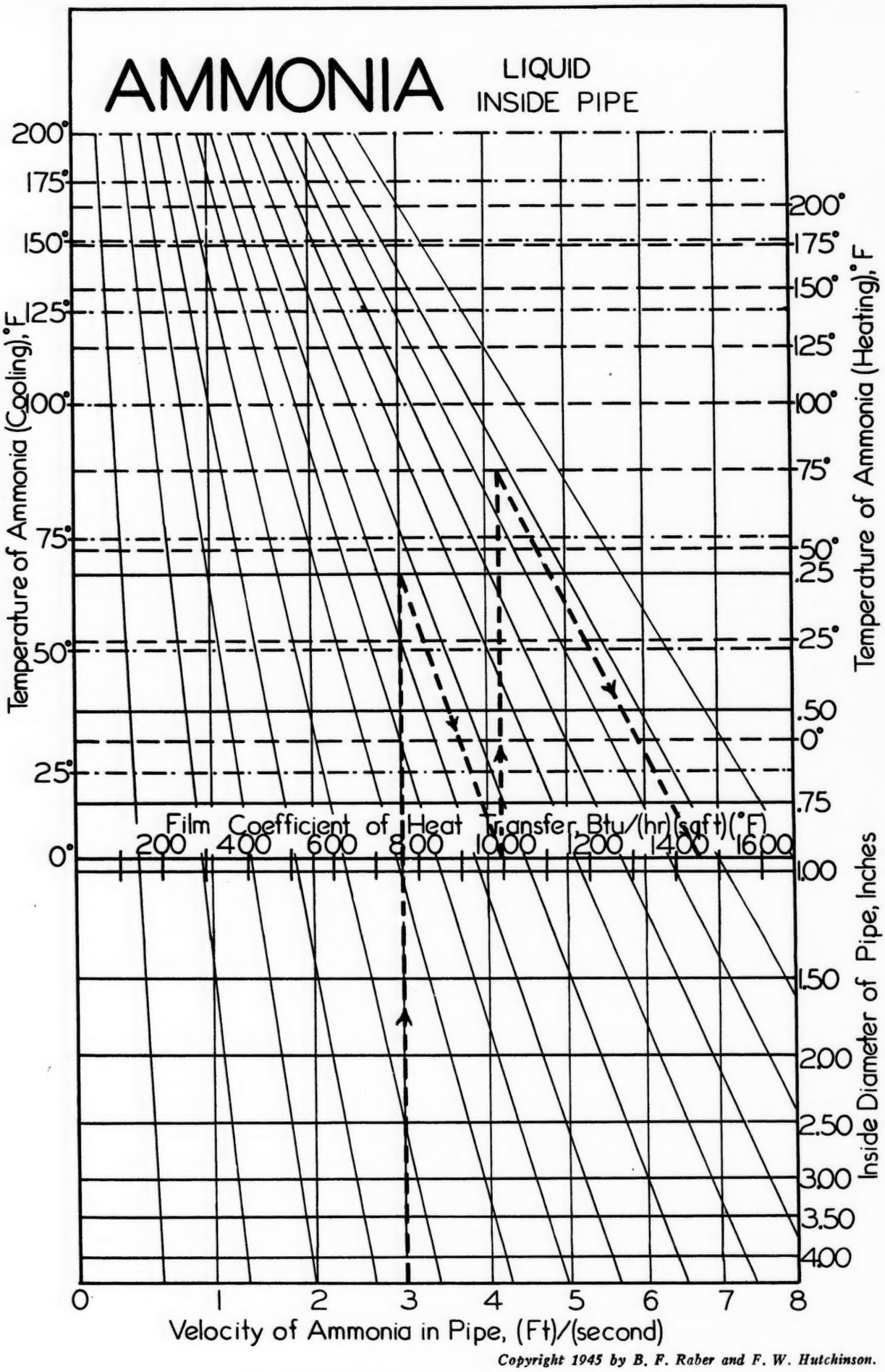

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Fig. 3. Film coefficient for ammonia flowing inside a pipe

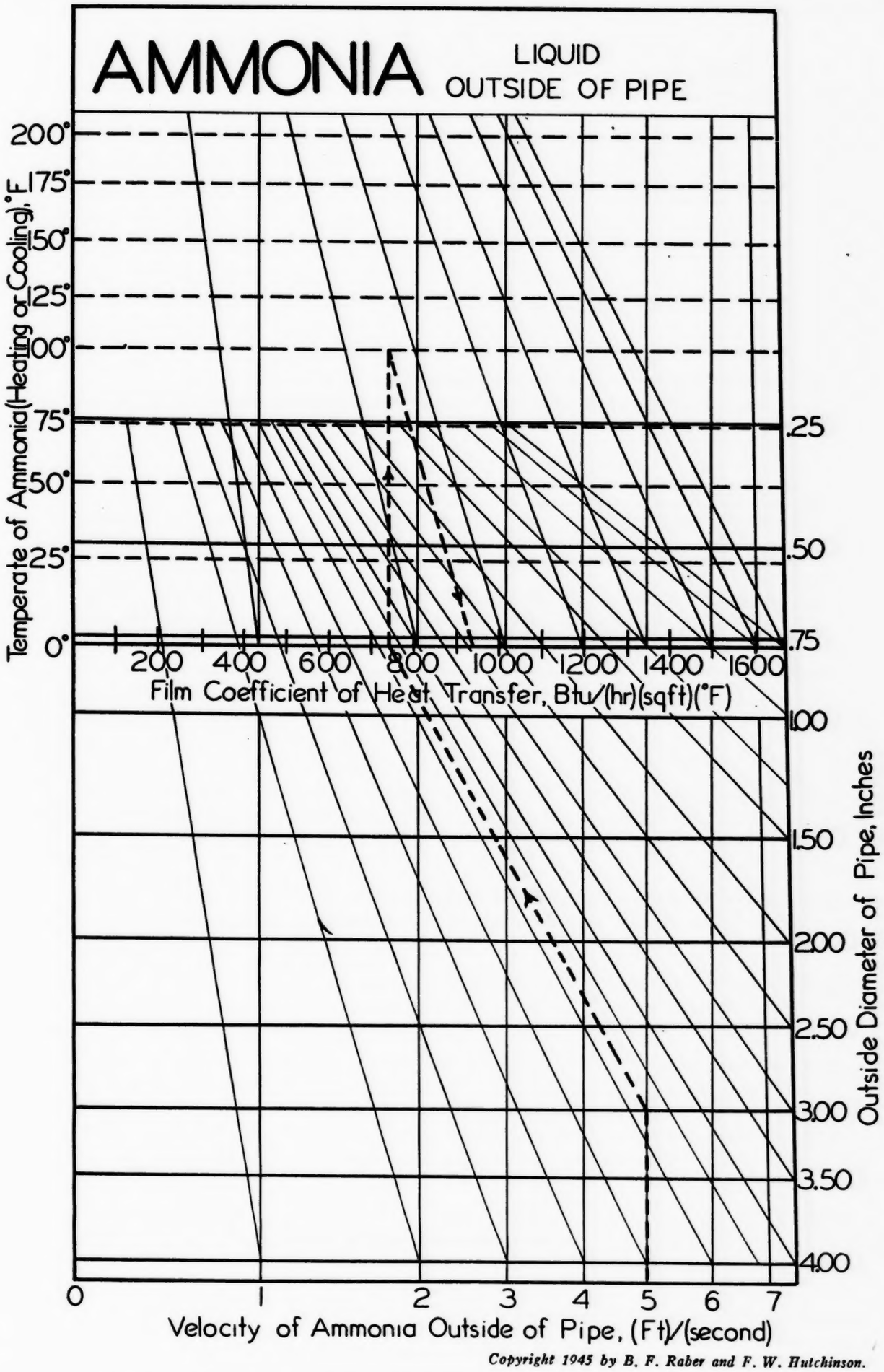

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Fig. 4. Film coefficient for ammonia flowing outside a pipe.

Over-all Coefficient of Heat Transfer

The value of a film coefficient as determined from one of the graphs could be used directly in Newton's law of cooling, provided the temperature of the filmed surface were known. Newton's equation is,

$$q = h\,A\,(t_f - t_s) \quad \ldots\ldots (1)$$

where,

q = Btu per hr,
h = film coefficient of heat transfer, Btu per hr per sq ft per F,
A = area of the transfer surface, sq ft,
t_f = temperature of the main body of fluid, F, and
t_s = temperature of the transfer surface, F.

Unfortunately the surface temperature is usually unknown and is not subject to simple experimental determination. In consequence, need exists for a more general equation from which the rate of heat transfer can be calculated as a function of the two (inside and outside the pipe) fluid temperatures. Such an equation can be written in terms of an over-all coefficient of heat transfer U′, or an over-all resistance factor R′, thus,

$$q = U'\,(t_h - t_c) = (t_h - t_c)/(R') \quad \ldots\ldots (2)$$

in which t_h and t_c are the temperatures, respectively, of the main masses of heating and of cooling fluid.

Equation 2 is of general form and is applicable to any steady state transfer system, irrespective of the size, shape, or curvature of the solid barrier through which heat is flowing. For the type of problem with which this series is concerned, transfer across pipe walls, the over-all coefficient of heat transfer can be evaluated from the equation.

$$U' = \frac{1}{\frac{1}{h_i A_i} + \frac{l}{k A_w} + \frac{1}{h_o A_o}} \quad \ldots\ldots (3)$$

where,

l = thickness of the pipe walls, feet,
k = thermal conductivity of the pipe, Btu per hr per sq ft per F per ft,
A_i = inside surface area of pipe, sq ft,
A_o = outside surface area of pipe, sq ft, and

$$A_w = \text{logarithmic mean area} = \frac{A_o - A_i}{\log_e (A_o/A_i)}$$

$$= \text{(approximately) arithmetical mean area} = (A_o + A_i)\ /\ 2$$

For any length of pipe, L feet, the over-all coefficient then becomes,

$$U' = \frac{L}{\frac{1}{h_i \pi d_i} + \frac{d_o - d_i}{k \pi (d_o + d_i)} + \frac{1}{h_o \pi d_o}} \quad \ldots\ldots (4)$$

in which d_o and d_i are the outside and inside pipe diameters expressed in feet. Now let U be the over-all coefficient per *lineal* foot of pipe and R the over-all resistance per *lineal* foot,

$$R = \frac{1}{h_i \pi d_i} + \frac{d_o - d_i}{k \pi (d_o + d_i)} + \frac{1}{h_o \pi d_o}$$

$$= r_i + r_p + r_o = \frac{1}{U} \quad \ldots\ldots (5)$$

where r_i, r_p, r_o are the thermal resistances, per *lineal* foot, of the inside film coefficient, the pipe wall, and the outside film coefficient, respectively.

Examination of equation 5 shows that the pipe resistance is a function of conductivity and of pipe size; hence, for standard pipe, it is readily possible to tabulate r_p in terms of nominal pipe size and of pipe material. The film resistances are seen to be independent of the kind of pipe used, but functions of the nominal size and of the film coefficient. Thus for any given kind of pipe a table can be set up in terms of nominal sizes from which the three individual resistances, r_i, r_p, and r_o, can be taken. The rate of heat transfer can then be calculated from the simple equation,

$$q = \frac{L\,(t_h - t_c)}{r_i + r_p + r_o} \quad \ldots\ldots (6)$$

in which the pipe length L and the fluid temperatures t_h and t_c are design constants, while the three resistances in the denominator are found by obtaining film coefficients from the graphical solutions then reading the resistances directly from Table 1.

Tabulation of Resistances

As shown in the preceding section, the three basic resistances to heat flow from fluid-to-fluid across a separating pipe wall can be tabulated as functions of pipe size, pipe wall material, and film coefficient of heat transfer. Table 1 gives the resistances for standard weight (Schedule 40, American Standards Association B-36-10), wrought-iron or wrought-steel pipe. In following articles, similar tables will be given for heavy and extra-heavy iron or steel pipe sizes, for copper and brass pipe, and for copper tubing. It should be noted particularly that each table is valid for *all* fluids; the resistances given are *not* limited to the particular fluid for which graphical film coefficients happen to be given in the article with which the table appears.

Example: A refrigerant at 100F is flowing in a 2 in. standard wrought-iron pipe under conditions such that the inside film coefficient is 200. Cooling water at 50F is outside the pipe and flowing under conditions which give an outside film coefficient of 800 Btu per hr per sq ft per F. Determine the length of pipe needed to permit a total cooling rate of 200,000 Btu per hr.

From Table 1 read r_p for a 3 in. standard wrought-iron pipe as .000601. Then entering Table 1 at $h_i = 200$ read $r_i = .00623$; entering at $h_o = 800$

(Concluded on page 117)

WASHINGTON NEWS

Summarized by LORING F. OVERMAN

Heating and air-conditioning engineers who have been devoting any appreciable part of their time to postwar blueprinting may as well run the chamois through the ruling pen and put the slide rule away until further notice.

Thanks to Field Marshal Von Runstedt, the scene has changed again in Washington. No talk of reconversion is heard in WPB offices. Those who might be tempted to speak out are not unmindful of the fact that the man who first insisted upon reconversion planning now makes his headquarters in China instead of the District of Columbia.

So until further notice—this time from General Eisenhower—civilian production may be expected to take a back seat, while whips will crack in an effort to meet material shortages that some may have suspected as existing only within the propaganda framework of the Sixth War Loan drive.

Serious Business

While some newspaper correspondents in Europe hinted during Christmas week of "another Dunquerque", Washington hadn't yet brought itself to the point of believing the military setbacks were other than temporary. Admitted, however, was the fact that German opposition had been underestimated, with the result that the brakes had been applied too quickly to some war programs, while others were being permitted to coast.

Determined that America's renewed war effort should not again be reckoned in terms of weeks or months, but in equipment necessary to really finish the job, Washington launched a barrage of stop-gap directives designed to turn the production tide back into war-needed channels.

Tire Making Authorized

Significant of Washington thinking was the approval "at this late date" of additional facilities to enlarge truck tire production by one third—with 1,000,000 additional truck tires per quarter as a goal. Expenditures of up to $100,000,000 for buildings and equipment, including some air conditioning, has been authorized. Wear and destruction of military tires in European operations has far exceeded estimates—a condition duplicated in several other supply programs.

During the time the new facilities are under construction, it may be expected that stepped-up military demand will be supplied at the expense of civilian transportation—with ramifications extending into every industry that moves on rubber.

Civilian "Freeze"

Freezing of all civilian programs involving controlled materials at levels permitted during the fourth quarter of 1945 was also ordered, while "spot authorization" for the resumption of civilian production was suspended in 58 critical labor shortage areas, as well as 45 other areas where spotty labor shortages are interfering with war production.

Manpower Commission officials also lent their support to the freeze, by cooperating with the Selective Service System in arranging for a review of deferments in the 26-37 age group, and for reclassification of all registrants who leave war jobs for civilian activities without approval by WMC and USES.

While it is indicated that 150,000 additional workers, in the right jobs, would break present bottlenecks, all official pronouncements dealing with war production swing a cat-o-nine-tails for the purpose of assuring that the relatively small number are kept in line. Loopholes are still provided, however, to permit limited resumption of civilian production in areas definitely out of the war production picture, but until that "further notice" comes from Eisenhower, it will doubtless prove unpopular to encourage a repetition of the "it's about all over" attitude.

Fuel Oil Affected

Users of some types of fuel oil are already feeling the effects of premature programs. On the assumption that several thousand oil tank cars would be needed on the West Coast more than on the East, the switch was made some months ago. On December 15th the Office of Price Administration announced that transportation conditions make it necessary that East Coast rations of residual oil for heating purposes again be figured on the original basis of two-thirds of normal requirements. Chief users are large hotels, office buildings, industrial plants and apartment houses.

OPA explained that the new provisions will not affect consumers who have already received additional rations of residual oil under the November relaxation. It merely means that local War Price and Rationing Boards will not issue any more increases in the East Coast area. However, users of residual oil, other than those who have received increases up to their full requirements, may apply for hardship rations.

It has been unnecessary to make changes in rations on fuel oils of types used in residential units, and the Petroleum Administration for War indicates it is taking all possible steps to continue supplies at present levels. Petroleum production at the rate of 5,040,800 barrels per day has been certified for January, and the present high average rate of 4,700,000 barrels per day must be continued throughout 1945 regardless of when Germany surrenders, the PAW reports.

Since the United States entered the war, crude oil production increased to a record high of 4,766,000 barrels daily in September, 1944. In the last pre-war year, 1941, the production averaged 3,842,000 barrels daily. Average production in 1943 was 4,118,000 barrels daily.

Oil Transport Effective

The possibility of civilian oil shortages is due to increased military consumption, rather than in any major flaw in the transportation system, the PAW indicates.

"The oil industry and the transportation companies are doing a phenomenal job," said Petroleum Administrator Ickes. "When the war began no one even imagined it would be possible to move 3,000,000 barrels of crude oil and products by overland route every day. But it is being done. However, military requirements are so large that it has been necessary to shift many tank cars and barges into military service and to utilize many of the pipelines for the same purpose. As a result, transportation of petroleum products for civilian use is tightest since the war began."

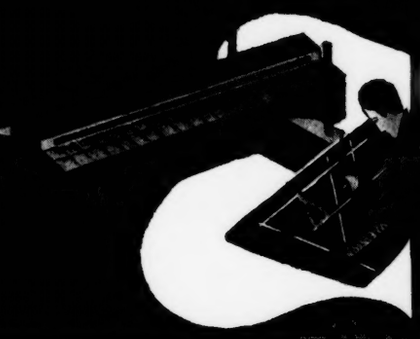
As an example of the many ramifications of the expanded munitions program, Mr. Ickes cited the fact that the PAW was recently required to release 600 tank cars for use in shipping sulfuric acid, a component vitally needed in the making of munitions.

Coal Tightens

Although summer storage eased the coal supply problem somewhat,

(Continued on page 115)

REVIEWS



Articles are abstracted for the convenience of the readers. Orders cannot be taken for the full length articles. Those desiring to obtain copies of the article referred to should write to the publishers of the respective articles.

HOUSING BOOM

Estimates on the demand for new dwelling units during the first year after the war range from 1,600,000 made by Johns-Manville to 300,000 made by the National Association of Real Estate Boards.

There seems to be a prevalent feeling that there will be a housing boom after the war. In "Your First Year of the Housing Boom," a report prepared by the Housing Institute, explanations are given of the steps one should take to cash in on the profitable war veterans market; how to tie in with prefabricators; how to utilize present and future labor resources to the greatest advantage; how to take advantage of population moves; new methods of financing; what is new in materials, heating, etc. This report for housing executives contains charts and tables.

Report published by The Housing Institute, Inc., Empire State Bldg., New York 1, N. Y. Price $5.

GAS AIR CONDITIONING

Two booklets, published by the American Gas Association Test Laboratory, Cleveland and Los Angeles, as supplements to Bulletin 18, also relating to gas summer air conditioning and published a year ago. The bulletins, entitled Research Bulletin No. 30 and 31, respectively, are titled "Performance Characteristics of Air Duct Systems and Review of Methods for Design and Calculations of Pressure Losses in These Systems" and "Survey of Water Problems Encountered with Summer Air Conditioning Equipment."

The preparation of each was supervised by the Joint Committee on Gas Summer Air Conditioning of the Industrial and Commercial Gas Section and Residential Gas Section, John DeB. Shepard, Chairman.

Bulletin 30, 20 pages, standard size, reviews the basic methods of duct design, gives a review of data available on pressure losses, a comparison of actual and computed pressure losses, a short study of installation problems encountered, and an appendix showing the methods of designing duct systems and computation of pressure losses.

Bulletin 31, 12 pages, standard size, covers a survey of water problems encountered with gas summer air conditioning equipment. The principal types of water which may be encountered are discussed and problems presented by each type are outlined. This study was made to present to air conditioning engineers a general idea of the scope of water problems and to indicate possible means of their solution. No attempt has been made to set forth specific remedies since each condition is subject to individual study and correction. General methods of water treatment only are given so as to provide a working background for solutions to this important problem. In general, no specific method of treatment should be employed unless reviewed and approved by a water chemist or water treatment engineer.

The bulletins are available from the American Gas Association Testing Laboratories, 1032 E. 62nd St., Cleveland 14, and 1425 Grande Vista Ave., Los Angeles 23.

BRIEF REVIEWS

DISTRICT HEATING—The official proceedings of the 35th annual meeting of the National District Heating Association in 1944 and including the papers and discussions presented at the meeting. Of particular interest are the reports covering Sizing Economizers and Condensate Coolers, Steam Consumption for Water Heating in Various Types of Buildings, Sprinkler Tank Water Temperature Control, New Methods for Heating Domestic Hot Water, Correlation of Amounts of Steam Used in Heating Different Buildings, Degree-Day Standardization, and Observations on the use of Cyclohexylamine in Steam Heating Systems.

SOLID-FUEL-BURNING FORCED AIR FURNACES—A recorded voluntary standard of the trade for solid-fuel-burning forced air furnaces is being distributed for the National Bureau of Standards by the Government Printing Office as Commercial Standard CS109-44—price 10c. The standard is quite extensive covering such subjects as general and construction requirements, performance requirements under test, test code, data and report sheet, methods for interpolating results, and suggested forms. A large number of associations and companies have accepted the standard as their standard of practice.

MULTIPLE TENANCY FOR FACTORIES—An 18-page multilithed publication entitled "Multiple Industrial Tenancy—One Solution for the Post-war War Plants Problem" and prepared by the Smaller War Plants Corporation, Office of Reconversion, to stimulate thinking and action on the problem of disposing of the large plants financed by the Government and built during the war. A good case is made for such multiple tenancy of these large plants.

PACKAGED FUEL—Bureau of Mines Report of Investigations No. R.I.3757 and entitled "Technical and Economic Study of Packaged Fuel," by V. F. Parry. The conclusions regarding the desirability and importance of this industry are most interesting. Booklet is standard size, multilithed, 45 pages. Available from the Superintendent of Documents.

RESEARCH IN ACTION—Within a period of 14 years the dollars spent for research for industry at Battelle Memorial Institute, Columbus, Ohio, has advanced from $50,000 in 1930 to $2,500,000 in 1944. The organization of the institute and the industrial research which it can carry on is explained in a 58-page liberally illustrated booklet. Clyde Williams, Director, Battelle Memorial Institute, Columbus, Ohio.

Tonnage that turned the tide

TUBE-TURN welding fittings weigh less—take only a fraction of the space. In the intricate piping systems of Victory ships, these savings increased tonnage capacity that helped turn the tide.

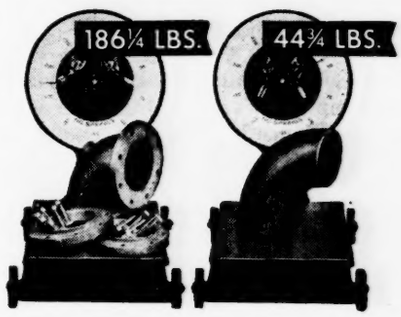
Weight-saving, space-saving, and low maintenance costs are important *in industry, too.* But they are only three of Tube Turns' many advantages over other fitting types. Tube-Turn welding fittings are easy to install. Their vibration-proof strength eliminates shut-downs for piping repairs. Their smooth inner surfaces insure maximum efficiency of flow. They permit greater flexibility of layout. Their greater strength means longer life for the entire system, increased safety at points of highest pressure . . . where direction of flow is changed.

For more information on the superiority of Tube Turns' exclusive manufacturing methods and data on successful installations in many industries, write for Catalog 111.

• • •

Selected Tube Turns Distributors in every principal city are ready to serve you from complete stocks.

TUBE TURNS (Inc.) Louisville 1, Kentucky. *Branch Offices:* New York, Chicago, Philadelphia, Pittsburgh, Cleveland, Dayton, Washington, D.C., Houston, San Francisco, Seattle, Los Angeles.



Less than 1/4 as much weight!
Actual weight of 8-inch cast iron flanged ell with flanges, bolts and nuts, 186¼ lbs. Actual weight of 8-inch Tube-Turn elbow to do the same job, 44¾ lbs.

TUBE-TURN
TRADE MARK

Welding Fittings and Flanges

NEWS OF THE MONTH

ASRE Celebrates 40th Annual Convention

John F. Stone

More than 800 members and guests attended the fortieth annual convention of the American Society of Refrigerating Engineers at the Hotel Pennsylvania, New York City, December 11-13. This was the largest convention attendance in the society's history.

Although there were many committee and council meetings on Sunday afternoon and Monday morning, the convention was formally opened on Monday afternoon by President A. B. Stickney. Harry Sloan, The Vilter Manufacturing Co., Milwaukee, a past-president, spoke of the early days of the society and of its formation. Others of the original charter members told of the 40 years advance of A.S.R.E.

In a paper on "Heat Operated Absorption Units," Dr. R. S. Taylor, Servel, Inc., Evansville, Ind., described a number of the two-fluid and three-fluid heat operated cycles.

Thermodynamic properties of moist air were covered by John A. Goff, Dean, Towne Scientific School, University of Pennsylvania, in his paper "Moist Air Research." The steps suggested by Dean Goff are the results of a study conducted at the university.

F. Y. Carter, Detroit Lubricator Co., Detroit, Mich., read a paper on "A Differential Temperature Expansion Valve for Low Temperature Applications." The valve has ample self-contained power for correct operation at low temperature; the valve can be used on any refrigerant not injurious to brass; the system pressure does not affect its operation; it can be adjusted to eliminate surging; it will maintain a constant superheat over a very wide suction temperature range.

"A Comparison of Methods for Controlling Evaporators and Compressors Used in Air Conditioning" was described by W. A. Grant, Carrier Corp., Syracuse, N. Y. Mr. Grant reviewed the fundamentals of evaporator and compressor control in the light of new developments and experience of the industry during the past decade.

W. P. Berggren and R. L. Perry, both of the University of California Agricultural Experiment Station, Davis, Calif., prepared a paper on "Pipe Insulation for Steady and Intermittent Refrigerating Service." Surface condensation will often determine the required thickness of insulation, especially in the case of intermittent service. The authors presented methods, and examples of their application, rather than specific recommendations.

During a session largely devoted to the subject of frozen foods, Dr. D. K. Tressler, Manager, General Electric Consumers Institute, Bridgeport, Conn., presented a paper on "Home Freezers—Present and Future." He cautioned against installing too small a unit as was done in the early days of domestic refrigeration. He also said that there were 192 manufacturers planning to build home freezers after the war.

Prof. J. E. Nicholas, The Pennsylvania State College, State College, Pa., described the "Quick Freezing Performance of an Experimental Sub-Zero Food Freezer." Results obtained with the experimental freezer were summarized.

A motion picture in color, prepared for the General Electric Co., on the preparation of foods for quick freezing was shown to a receptive audience.

In "The Future of Refrigeration Engineering," Richard Poole, Birds Eye-Snider, Inc., New York City, reported on a survey conducted for the society. Answers to 8 questions were summarized.

A. J. Langhammer, Amplex Division, Chrysler Corp., Detroit, Mich., prepared a short paper on "Powdered Metallurgy." While uses for this new art are increasing, it has limited use for machine tools.

Clifford F. Holske, The Vilter Manufacturing Co., New York, N. Y., described "Refrigeration for Penicillin Manufacture," touching on the equipment required and the manufacture of the powder.

George A. Belsky, Mance Corp., New York City, in his paper "Refrigeration as Applied to Lyophilization," described the equipment for lyophilization installed in a recently completed penicillin plant. Lyophilization is the process of dehydrating a frozen substance.

Prof. Carl Kayan of Columbia University, New York City, spoke on "Temperature Distribution in Complex Wall Structures by Geometrical Electrical Analogue." The advantage of geometrical similarity to actual configurations makes it an attractive working tool.

At a luncheon meeting, Dr. H. N. Davis, President, Stevens Institute of Technology, Hoboken, N. J., spoke on industrial research. He said that the country will soon see a surge of industrial research such as has never been seen before. Recent advances have been made in fields where it was popularly believed we knew all there is to know about the subject such as in the realms of paper manufacture, metal milling, and blast furnace operation. An inquiring mind will find many things to learn. What we do is either research or routine. If one has done the work before, it is routine; if one has never done the work before, it is research.

The Wolverine Prize, a gold medal with a diamond inset for the best paper in *Refrigerating Engineering*, was presented to Major David L. Fiske.

The prize for the best section's paper award went to Dr. Walter O. Walker, Ansul Chemical Co., a member of the Milwaukee section.

George A. Horne, a past-president of the society, was made an honorary member.

Charters were granted to two new sections — New Orleans and the Pacific Northwest groups.

The new officers are President, John F. Stone, manager of refrigeration division, Johns-Manville; Vice-President, Charles S. Leopold, Consulting Engineering, Philadelphia, Pa.; Vice-President, Roland H. Money, chief refrigeration engineer, The Crosley Corp., Treasurer, John G. Bergdoll, Jr., York Corp.

Survey Indicates Slow Reconversion

NEW YORK—A survey by the Producers' Council, Inc., national organization of manufacturers of building materials and equipment, indicates that it will take several months after reconversion to achieve production of 50% of the 1939 rate of plumbing, heating and air conditioning supplies.

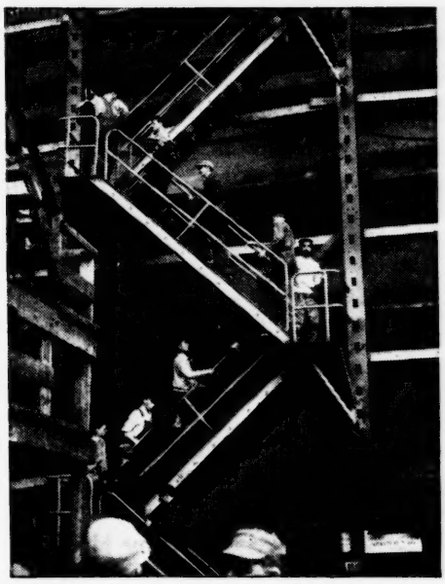
Smoke Abatement Director for L. A.

LOS ANGELES—The Los Angeles city council on November 9 approved an ordinance creating the post of Director of the Bureau of Atmospheric Pollution Control. The person filling this post is charged with the duty of devising ways and means for controlling smoke and irritating fumes so that the nuisance of air pollution, which in recent months has caused widespread complaint, can be eliminated.

MEN AGAINST MISHAP

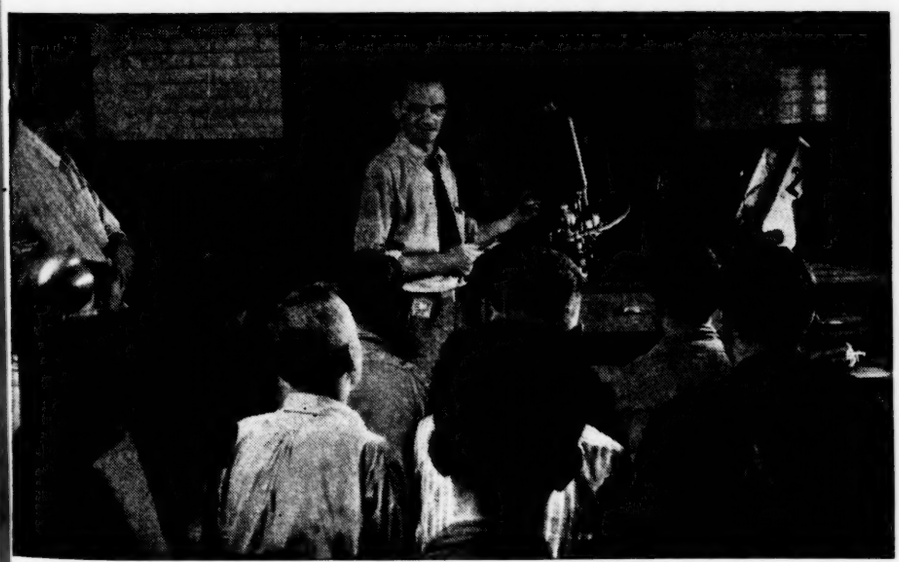
SIGNS LIKE THIS, at strategic locations, are helping twenty-four hours a day to promote safe working practices in Bethlehem steel plants and shipyards.

SAFETY CAP, worn by many women employees, is made of light, cool cotton, with snood covering hair. Visor shades eyes, and serves as a bumper to warn wearer in case her head approaches too close to work.



STAIRWAYS FOR SHIPBUILDERS, in a Bethlehem yard, take the place of long side-shell ladders. Traffic is one-way, and employees may carry small tools and materials, dangerous on an ordinary ladder.

SAFETY INSTRUCTION. Bethlehem employees doing specialized work and using protective respiratory equipment are trained by safety supervisors with many years of experience.



IN Bethlehem steel plants and shipyards, there's a never-ending battle being fought—a campaign against that wily old tactician, General Mishap. The general is wise in the ways of human frailty, and a master of feints, flanking maneuvers and ambuscades. The results of his forays can be serious indeed. Industrial accidents are deplorable any time and anywhere, but in wartime they are, in addition, an effective saboteur of vital production.

Ever since the war emergency developed, and thousands of men and women, without experience in industrial work, began to enter its plants and shipyards, Bethlehem has been redoubling its efforts toward employee safety. Physically, by means of new safety devices, and more protective clothing, safety shoes, goggles, helmets, and the like. Educationally, by a stepped-up program of safety meetings and first-aid instruction, bolstered by signs, posters and warning flags, lectures, booklets and motion pictures.

The safe way of doing his job is impressed upon the new Bethlehem employee from his first day of work. And safe working practices and the avoidance of hazards are continually emphasized to newcomers and veteran workers alike.

Thanks to the unceasing effort to make safer workers and safer working conditions, even during this wartime era of peak production and the largest working force in Bethlehem history, our safety standards have steadily risen.

Significant of what has been accomplished in making war work safer for the worker is this encouraging fact: statistics show that *the Bethlehem worker runs less danger of being injured while at work in the plant, than during his spare time when he is off the job.*

WORLD'S LARGEST SHIPBUILDER

★ ★ BETHLEHEM STEEL ★ ★

SECOND LARGEST STEEL PRODUCER

Steel, Manufacturing and Fabricating Plants at . . . Bethlehem, Steelton, Williamsport, Johnstown, Lebanon, Pottstown, Rankin, Leetsdale, Pa. . . . Buffalo, Lackawanna, N. Y. . . . Sparrows Point, Md. . . . Chicago, Ill. . . . Tulsa, Okla. . . . Corsicana, Tex. . . . South San Francisco, Los Angeles, Alameda, Calif. . . . Seattle, Wash. *Shipbuilding and Ship Repair Yards* . . . Quincy, Hingham, East Boston, Mass. . . . Staten Island Brooklyn, N. Y. . . . Hoboken, N. J. . . . Baltimore, Fairfield, Sparrows Point, Md. . . . San Francisco, Alameda, San Pedro, Calif.

Refrigeration for Maracaibo

CARACAS—Maracaibo, one of Venezuela's chief seaports and oil-producing centers, will soon have additional facilities for preserving and distributing perishable foodstuffs with the completion of two refrigeration plants planned by the Ministry of Agriculture and Animal Husbandry here. Recent press reports fom Maracaibo indicate that work has already begun on the installation of refrigerating machinery obtained in the United States.

Each of the chambers will measure almost 25 feet in length, 13 feet in breadth and seven and a half feet in height, offering a capacity of approximately 64 cubic yards for the refrigerated storage of almost 20,000 pounds of perishable foods. Freon gas will be used with compressors in each of the chambers to provide controlled temperatures ranging from 33 degrees Fahrenheit to 39 degrees Fahrenheit.

In the planning and construction of the refrigerating chambers, officials of the Ministry of Agriculture and Maracaibo City Council were aided, in a consultative capacity, by Romualdo J. Blas and Kenneth W. Baker, technicians of the Institute of Inter-American Affairs, an agency of the Office of Inter-American Affairs in Washington.

IBR Prepares for Post-War Markets

NEW YORK—The first steps in a program to secure for the radiator heating industry a substantial share of the residential heating business during the post-war period were taken at the annual meeting of The Institute of Boiler and Radiator Manufacturers at Rye, New York, in October. Members and associate members of the Institute heard recommendations of committees outlining current activities and a long-range program for the future.

To provide wider representation on Institute committees, a reorganization effective January 1 was approved. The reorganization plan provides for the setting up of a general engineering committee on which every member of the Institute will be represented. Working under the supervision of the engineering committee will be five committees: boiler technical, radiation technical, research, installation, and boiler rating.

These committees will absorb and take over the functions of several existing committees. Each committee will have its own chairman and each chairman will report to the engineering committee.

Among the technical and engineering matters discussed at the October meeting of the Institute were amendments to the I-B-R code for testing and rating low pressure heating boilers; the recommendations of the Stoker Manufacturers Association regarding firebox dimensions; suggested changes in the convector code; and a proposed boiler construction code.

Much of the discussion at the Institute meeting centered around the research program at the University of Illinois where the Institute maintains the I-B-R Research Home.

A technical manual known as Installation Guide No. 1 is now on the press. This manual will make available to contractors, architects, and engineers the results of the research work at the University of Illinois applying to the design and installation of hot water heating systems.

At the business meeting of the Institute, A. E. Bastedo, vice-president, Burnham Boiler Corporation, was elected chairman of the Institute to succeed W. H. Stockwell who served two terms. R. E. Ferry, general manager of the Institute, was re-elected treasurer.

ASHVE Annual Meeting Program

NEW YORK—Ventilation, air conditioning and corrosio are among the subjects to be featured on the progra of the 51st annual meeting of the American Society Heating and Ventilating Engineers to be held at th Hotel Statler, Boston, January 22-24. The technic program follows:

JANUARY 22, P.M.

Studies of the Mechanism of Solution of CO_2 in Condensates form in Steam Heating Systems of Buildings, by L. F. Collins;
Preventing the Solution of CO_2 in Condensates by Venting of t Vapor Space of Steam Heating Equipment, by D. S. McKinne J. J. McGovern, C. W. Young and L. F. Collins; and
Summer Weather Data and Sol-Air Temperature—Study of Da for New York City, by C. O. Mackey and E. B. Watson.

JANUARY 23, A.M.

Altitude Chamber for Study of Heating and Air Conditioning Pro lems, by W. E. Crowell;
Thermodynamic Properties of Moist Air, by J. A. Goff; a Air Cooling Coil Problems and their Solutions, by L. G. Seig

JANUARY 23, P.M.

A Survey of Testing Methods and Rating Limits for Domes Heating Devices, by R. S. Dill;
Influence of Heat Capacity of Walls in Interior Thermal Con tions and Heat Economy, by Winslow, Herrington a Lorenzi; and
Radiation Corrections for Basic Constants Used in the Design All Types of Heating Systems, by B. F. Raber and F. Hutchinson.

JANUARY 24, A.M.

Control of Industrial Atmospheres, by W. H. Witheridge; M
Ventilation and Its Relation to Health and Safety, D. Harrington; and
Air Requirements for Satisfactory Ventilating and Odor Contr by C. S. Leopold.

The annual banquet will be held the evening of Ja uary 23.

Army Hospital Ventilation Criticized

WASHINGTON—The House Military Affairs Committ which has been investigating eighty-nine Army hos tals, reported December 27 that conditions in gene were favorable but cited some cases where the situati was not so good.

The committee complained that in ventilation and conditioning "a considerable lack of uniformity w uncovered."

"It seems that for determining whether or not conditioning is necessary, the War Department h theoretically divided the country into thermal zo which are based upon, and enclosed within, mean hi and average low temperatures," it stated. "An arbitra thermometric reading is then established, and that termines whether a hospital gets or does not get conditioning equipment.

"It is not clear to the committee why maximum te peratures and humidities actually encountered, rat than averages, are not made the determining factor

Virginia Studies Boilers

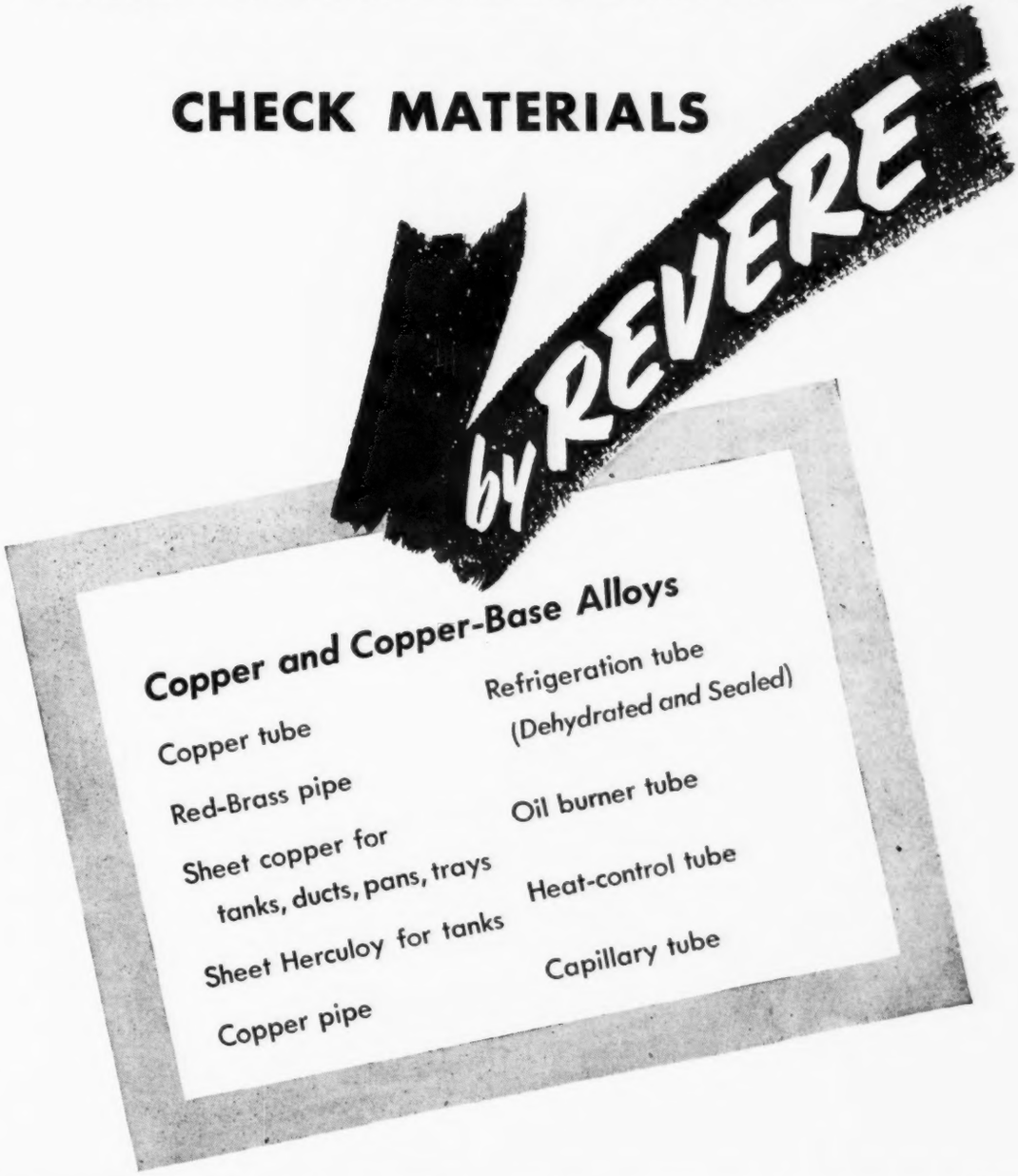
RICHMOND, VA.—Boiler legislation is the subject of of 17 interim studies being undertaken by the Virgi Advisory Legislative Council, which at a meeting h Sept. 25 named Senator Edward L. Breeden Jr. as cha man and assigned topics.

Henry G. Ellis

TORRINGTON, CONN.—Henry Gibbs Ellis, president The Torrington Manufacturing Co., died December 1.

FOR HEATING, VENTILATING AND AIR-CONDITIONING WORK:

CHECK MATERIALS



Whatever your problem may be in the application or use of copper or copper alloy, pipe, tube or sheet, we can help you in THESE ESSENTIAL WAYS:

1 *Advise you* in the selection of the proper material and recommended methods of installation, so as to save time in the shop and on the job, and thus reduce costs wherever possible.

2 *Give you* advice on Welding techniques—practical assistance which will help speed up this process that is so important in many installations.

3 *Send you* our booklet, "Revere Pipe and Tube", latest edition.

These three services are available to you without obligation. Address Revere Executive Offices.

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Executive Offices: 230 Park Avenue, New York 17, N.Y.

Degree-Days for November, 1944

HEATING AND VENTILATING'S 18TH YEAR OF PUBLICATION OF MONTHLY DEGREE-DAY DATA

CITY	NOVEMBER			CUMULATIVE, SEPTEMBER 1 TO NOVEMBER 30			HEATING SEASON
	1944	1943	NORMAL	1944	1943	NORMAL	NORMAL
Abilene, Texas	314	302	333	366	380	333	2061
Albany, New York	786	871	774	1347	1527	1292	6580
Albuquerque, New Mexico	660	624	630	881	888	903	4298
Alpena, Michigan	778	909	912	1546	1785	1704	8299*
Anaconda, Montana	1082	929	951	1802	1710	1933	8357*
Asheville, North Carolina	596	609	576	885	1039	852	4232
Atlanta, Georgia	422	411	396	560	604	492	2890
Atlantic City, New Jersey	553	562	588	840	900	842	5176
Augusta, Georgia	327	335	321	398	440	337	2161
Baker, Oregon	907	792	849	1466	1424	1659	7163
Baltimore, Maryland	515	536	567	788	863	790	4533
Billings, Montana	893	760	909	1422	1313	1622	7119
Binghamton, New York	750	841	798	1374	1525	1359	6808
Birmingham, Alabama	390	487	318	479	680	318	2352
Bismarck, North Dakota	1155	1038	1113	1851	1690	1961	9192
Block Island, Rhode Island	602	592	573	985	985	852	5788
Boise, Idaho	786	750	738	1138	1158	1274	5552
Boston, Massachusetts	657	648	693	1110	1123	1104	6045
Bozeman, Montana	982	902	1006	1719	1696	1993	8521*
Buffalo, New York	695	827	774	1281	1530	1268	6822
Burlington, Vermont	832	900	861	1584	1659	1486	7514
Butte, Montana	1091	977	923	1935	1889	1922	8272
Cairo, Illinois	470	569	519	635	811	677	3909
Canton, New York	859	921	906	1645	1743	1652	8020
Charles City, Iowa	786	1014	936	1350	1761	1505	7588
Charleston, South Carolina	247	272	207	293	338	207	1769
Charlotte, North Carolina	438	416	426	607	618	541	3120
Chattanooga, Tennessee	490	560	426	701	799	531	3118
Cheyenne, Wyoming	875	847	900	1589	1625	1745	7466
Chicago, Illinois	620	863	450	1070	1393	800	5957
Cincinnati, Ohio	611	679	615	943	1056	869	4684
Cleveland, Ohio	618	737	732	1082	1272	1125	6155
Columbia, Missouri	581	702	651	816	1068	911	4922
Columbia, South Carolina	340	358	324	437	472	355	2364
Columbus, Ohio	637	684	690	1005	1134	1003	5398
Concord, New Hampshire	843	849	846	1559	1578	1498	7353
Concordia, Kansas	653	732	693	908	1128	969	5315
Dallas, Texas	259	317	303	289	401	303	2256
Davenport, Iowa	670	857	795	1027	1336	1158	6289
Dayton, Ohio	685	782	660	1081	1262	933	5264
Denver, Colorado	688	680	759	1081	1117	1259	5874
Des Moines, Iowa	698	880	798	1052	1414	1155	6384
Detroit, Michigan	676	804	777	1155	1422	1219	6490
Devils Lake, North Dakota	1146	1147	1179	1943	1984	2161	9970
Dodge City, Kansas	621	675	672	909	1027	948	5035
Dubuque, Iowa	734	919	846	1187	1519	1291	6790
Duluth, Minnesota	924	1179	1074	1759	2118	1970	9443
Eastport, Maine	754	806	843	1536	1565	1662	8520
Elkins, West Virginia	750	770	741	1341	1459	1182	5697
El Paso, Texas	412	412	381	461	487	421	2428
Ely, Nevada	1034	866	—	1824	1600	—	—
Erie, Pennsylvania	603	757	711	993	1326	1125	6273
Escanaba, Michigan	800	979	960	1593	1871	1794	8771
Evansville, Indiana	558	668	528	852	1036	683	4244
Fort Smith, Arkansas	365	442	408	420	592	470	3147
Fort Wayne, Indiana	724	856	726	1244	1495	1073	5925
Fort Worth, Texas	260	297	252	284	373	252	2148
Fresno, California	407	329	315	427	435	334	2334
Galveston, Texas	109	156	60	114	184	60	1016
Grand Junction, Colorado	707	710	747	919	981	1116	5548
Grand Rapids, Michigan	693	825	774	1211	1451	1250	6535
Green Bay, Wisconsin	739	994	921	1399	1768	1558	7825
Greensboro, North Carolina	544	554	492	815	879	635	3529
Greenville, South Carolina	453	445	450	621	657	596	3380
Harrisburg, Pennsylvania	622	700	660	1040	1165	989	5375
Hartford, Connecticut	741	752	705	1258	1286	1097	6036
Hatteras, North Carolina	327	331	234	401	423	234	2571
Havre, Montana	1195	865	1041	1802	1565	1931	8700
Helena, Montana	1027	964	948	1800	1738	1813	7898
Houston, Texas	147	195	114	155	236	114	1157
Huron, South Dakota	949	983	1005	1561	1653	1654	8004
Indianapolis, Indiana	625	745	687	951	1163	985	5298
Jackson, Mississippi	266	—	—	341	—	—	—
Kansas City, Missouri	556	698	639	724	1041	858	4956
Kewanee, Illinois	639	910	781	985	1464	1193	6139
Knoxville, Tennessee	(a)	546	519	(a)	850	702	3670
La Crosse, Wisconsin	735	1026	909	1252	1787	1467	7322
Lander, Wyoming	1189	927	726	1959	1654	1656	7947

*Figures in this column are normal totals for a complete heating season, September to June, incl.

Figures in this table, with nine exceptions, based on local weather bureau reports. Exceptions are Utica, Lewiston, Kewanee, Sioux City, and Jackson, figures for which are furnished through the courtesy of Coke Sales Department, Central New York Power Corp., Utica, N. Y.; Norman E. Ross, Bursar, Bates College, Lewiston, Me.; J. M. Hartman, Engineering Department, Kewanee Boiler Corp., Kewanee, Ill., Alfred R. Wagstaff, Engineer, Sioux City Foundry and Boiler Co., Sioux City, Iowa, and H. M. Ludlow, 1368, Jackson, Miss., respectively; Anaconda, Bozeman, Butte and Livingston, Mont., through the courtesy of the Montana Power Company.

(a) Data not available.

[Table concluded on page

PANEL HEATING FOR THE POST-WAR HOME

Radiant Heating Provides Comfort Despite Extensive Use of Glass

The use of large glass areas in modern residential construction poses an important heating problem. To provide maximum livability a form of heating must be used which will assure complete comfort at reasonably low air temperatures.

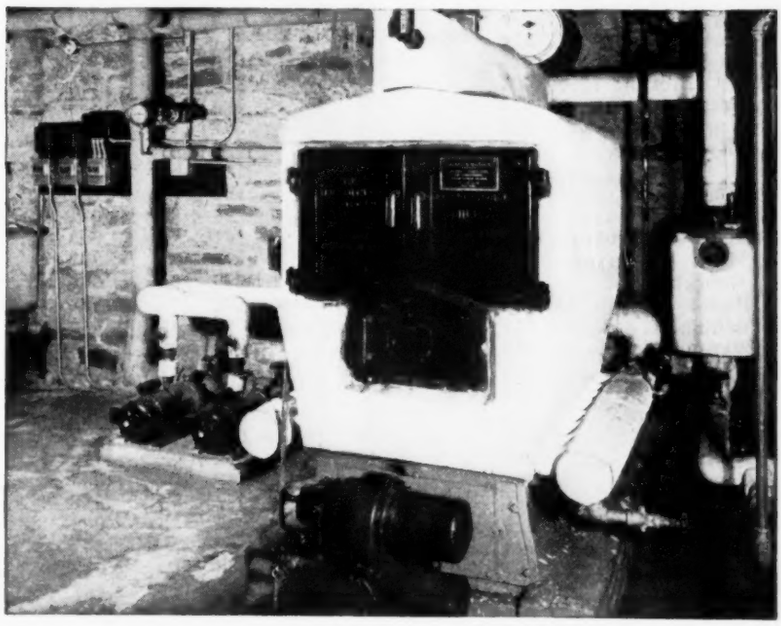
Architect Ralph Pomerance, now an Army Officer, solved this problem in his own home, recently built in Cos Cob, Conn., by using radiant heating. As a result air temperatures of 70° are quite high enough in even the most exposed rooms. With conventional forms of convected heat, it would be necessary to maintain air at nearly 80° to offset the low temperatures of the glass surfaces.

HOW TO HANDLE HEAT GENERATION FOR RADIANT HEATING SYSTEMS

A booklet just published by H. B. SMITH is a must for architects, engineers, and contractors who are interested in the generation as well as the distribution elements of panel heating systems.

For your free copy just write to THE H. B. SMITH CO., INC. 51 MAIN ST., WESTFIELD, MASS.

H.B. Smith
CAST-IRON BOILERS



HEAT GENERATION PROBLEM SOLVED: Wolff and Munier of New York City, radiant heating pioneers in the United States, designed and installed the entire system. An H. B. SMITH No. 240 Mills oil burning water tube boiler was selected because of its unusual flexibility of operation. Water in the boiler is maintained at 160° which is mixed with the return water to maintain temperatures of from 110° — 130°, depending on requirements determined by a conventional, outdoor-indoor control.

Degree-Days for November, 1944 (Concluded)

HEATING AND VENTILATING'S 18TH YEAR OF PUBLICATION OF MONTHLY DEGREE-DAY DATA

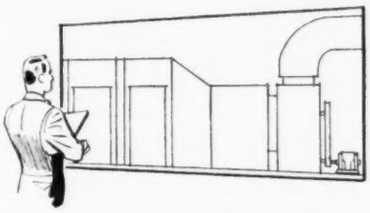
CITY	NOVEMBER			CUMULATIVE, SEPTEMBER 1 TO NOVEMBER 30			HEATING SEASON[1]
	1944	1943	NORMAL	1944	1943	NORMAL	NORMAL
Lansing, Michigan	761	896	861	1422	1662	1456	7048
Lewiston, Maine	835	889	876	1577	1660	1542	7707
Lincoln, Nebraska	731	819	753	1031	1267	1069	5999
Little Rock, Arkansas	376	457	381	463	600	428	2811
Livingston, Montana	944	751	864	1691	1399	1614	7205
Los Angeles, California	182	52	123	221	101	123	1504
Louisville, Kentucky	537	618	552	782	913	738	4180
Lynchburg, Virginia	588	508	537	905	815	757	3980
Macon, Georgia	350	385	324	444	519	330	2201
Madison, Wisconsin	746	972	891	1288	1657	1437	7429
Marquette, Michigan	814	989	960	1583	1868	1752	8693*
Memphis, Tennessee	404	495	402	544	688	464	2950
Meridian, Mississippi	319	418	312	418	540	334	2160
Milwaukee, Wisconsin	709	930	846	1221	1621	1380	7245
Minneapolis, Minnesota	819	1066	963	1384	1782	1537	7850
Modena, Utah	893	810	831	1425	1311	1504	6562
Montgomery, Alabama	267	338	273	322	447	273	1884
Nantucket, Massachusetts	604	578	609	985	983	1007	5957
Nashville, Tennessee	494	548	483	703	797	619	3507
New Haven, Connecticut	694	712	693	1160	1209	1092	5895
New Orleans, Louisiana	114	199	102	127	259	102	1024
New York, New York	571	607	618	889	989	894	5347
Nome, Alaska	1088	1023	1126	1830	1804	1870	14580**
Norfolk, Virginia	420	402	411	556	599	510	3350
North Head, Washington	493	408	510	962	944	1131	5452**
North Platte, Nebraska	824	783	837	1251	1303	1313	6366
Oakland, California	364	297	330	583	534	603	3143**
Oklahoma City, Oklahoma	404	441	459	489	587	564	3613
Omaha, Nebraska	738	877	780	1058	1366	1109	6131
Oswego, New York	733	798	783	1340	1491	1356	7088
Parkersburg, West Virginia	629	682	624	1008	1116	909	4775
Peoria, Illinois	661	860	789	1068	1365	1173	6109
Philadelphia, Pennsylvania	530	574	588	815	902	830	4855
Phoenix, Arizona	234	110	156	234	134	156	1405
Pittsburgh, Pennsylvania	601	697	669	987	1203	982	5235
Pocatello, Idaho	976	824	813	1576	1362	1468	6655
Portland, Maine	806	828	807	1540	1560	1446	7218
Portland, Oregon	537	493	558	818	802	995	4469
Providence, Rhode Island	643	639	693	1035	1100	1104	6015
Pueblo, Colorado	759	765	741	1159	1283	1135	5514
Raleigh, North Carolina	462	465	429	649	682	559	3234
Rapid City, South Dakota	961	873	870	1494	1459	1529	7118
Reading, Pennsylvania	595	650	669	979	1088	1013	5389
Red Bluff, California	423	—	—	452	—	—	—
Reno, Nevada	803	740	714	1332	1254	1311	5892
Richmond, Virginia	483	493	456	712	768	617	3695
Rochester, New York	726	835	786	1351	1535	1289	6732
Roseburg, Oregon	594	494	561	852	806	1022	4428
Roswell, New Mexico	485	529	516	642	717	702	3484
Sacramento, California	403	299	351	437	409	422	2653
St. Joseph, Missouri	614	756	633	822	1133	881	5161
St. Louis, Missouri	552	637	597	742	912	802	4585
Salt Lake City, Utah	757	749	723	1038	1109	1129	5555
San Antonio, Texas	220	255	126	236	307	126	1202
San Diego, California	157	111	165	188	143	199	1645
Sandusky, Ohio	636	754	726	1057	1250	1079	6208
San Francisco, California	273	172	261	549	404	521	3264**
Sault Ste. Marie, Michigan	913	1012	978	1852	2008	1877	9285**
Savannah, Georgia	214	214	201	249	283	201	1490
Scranton, Pennsylvania	719	779	732	1293	1388	1189	6129
Seattle, Washington	515	497	570	839	908	1150	4934**
Sheridan, Wyoming	919	843	978	1484	1560	1878	8008
Shreveport, Louisiana	262	367	270	320	458	270	1938
Sioux City, Iowa	833	963	870	1302	1551	1318	6898
Spokane, Washington	846	825	819	1329	1386	1526	6355
Springfield, Illinois	1019	737	681	1277	1095	963	5373
Springfield, Missouri	558	641	564	780	1022	781	4428
Syracuse, New York	734	831	798	1353	1546	1319	6893
Tacoma, Washington	568	556	588	981	1043	1195	5181**
Terre Haute, Indiana	595	727	615	902	1104	848	4872
Toledo, Ohio	719	818	732	1242	1449	1110	6077
Topeka, Kansas	567	691	639	742	1019	875	4969
Trenton, New Jersey	597	633	588	969	1071	830	4933
Utica, New York	823	895	781	1528	1632	1393	6796
Valentine, Nebraska	945	904	897	1509	1499	1480	7039
Walla Walla, Washington	729	724	651	979	1088	1013	4808
Washington, D. C.	526	551	594	830	893	845	4626
Wichita, Kansas	525	627	636	698	882	828	4673
Williston, North Dakota	1181	1001	1137	1863	1743	2067	9323
Winnemucca, Nevada	930	755	810	1432	1220	1509	6427*
Yakima, Washington	802	759	780	1072	1190	1337	5599

*Includes August.
**Includes July and August.
(a) Data not available.
[1]Figures in this column are normal totals for a complete heating season, September to June, incl.

THREE MEN ON AN AIR FILTER

—they all agree on Dust-Stop Air Filters!*

When the man who engineered the system—the man who bought it—and the man responsible for keeping it operating at high efficiency, continue to give Dust-Stops their enthusiastic approval, year after year—it's evidence of a preference worth investigating.



The Heating and Ventilating Engineer prefers Dust-Stops and the patented and complete, ready-to-assemble steel cell frames because of their ready adaptability to virtually any system, regardless of the C.F.M. requirements.

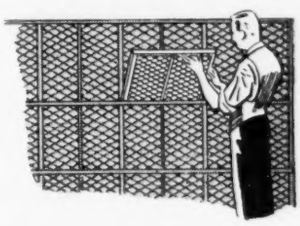
The proved efficiency of the Dust-Stop, flexibility of installation, easy access to filters, and the low cost of this part of the system are but a few of the other reasons why so many engineers have standardized on Dust-Stops.

The Treasurer, with an eye to original cost and upkeep, bases his preference on his cost records. They show that his company is obtaining the advantages of efficient air filtering at a low initial cost and at low upkeep cost.

AND the Maintenance Engineer casts his vote for Dust-Stops because they help him keep his budget down. Maintenance and/or replacement of Dust-Stops in the "L" and "V" frames are accomplished with a minimum of man power and time. There is no storing problem — low-cost replacement Dust-Stops can be quickly obtained from near-by suppliers. And the expense, nuisance and other difficulties of laundering are avoided.

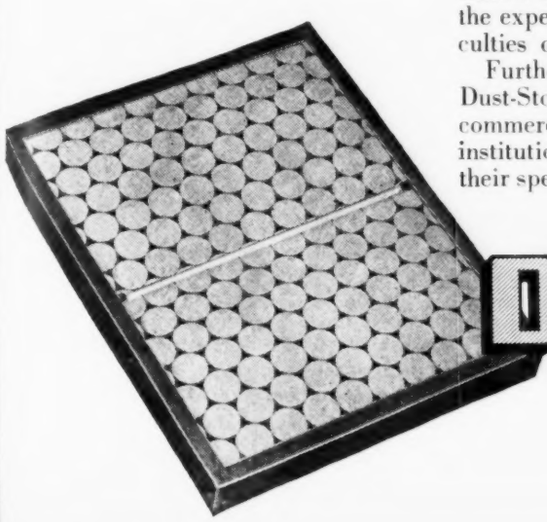
Further proof of the preference for Dust-Stops is their use in factories, commercial buildings, schools and institutions from coast-to-coast — and their specification by design engineers as component parts of many types of machinery to protect precision parts, increase efficiency or to facilitate operation under adverse conditions.

The Dust-Stop Air Filter is made of packs of glass fibers coated with an adhesive, faced with metal grilles and bound on the edges with a fiberboard frame. The high efficiency of Dust-Stop Air Filters is made possible by the Fiberglas filter medium and the nonodorous, nonevaporating adhesive.



Due to extraordinary wetting power each particle of dust acts as a wick to carry adhesive to other particles. Therefore, the effectiveness of the Dust-Stop is maintained until it becomes heavily coated with dust.

For complete information and typical installation details for both "L" type and "V" type frame arrangements see Sweet's Files or write: *Owens-Corning Fiberglas Corporation. 1912 Nicholas Bldg., Toledo 1, Ohio. In Canada, Fiberglas Canada Ltd., Oshawa, Ontario.*



DUSTOP® AIR FILTERS

®T. M. REG. U. S. PAT. OFF.

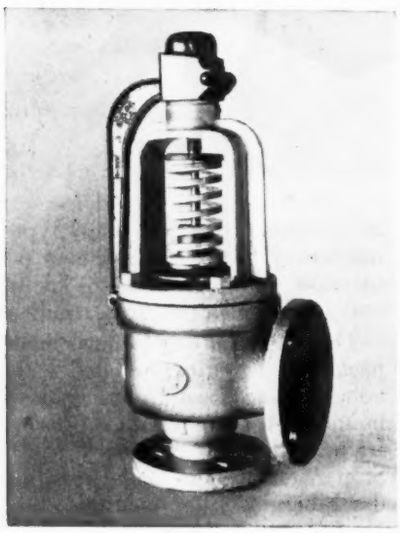
ARMY E NAVY

—a FIBERGLAS product

NEWS OF EQUIPMENT AND MATERIALS

Farris Safety Valve

NAME—Farris type safety valve.
PURPOSE—For steam boilers.
FEATURES—Special provisions for constant accurate blow-off, great capacity, tightness of re-seating, minimum escape of taper into surrounding



space, and elimination of angular distortion and fouling. Inlet venturi tube nozzle of this design gives unobstructed port and guided high velocity of steam, which results in high lift and corresponding capacity. Has patented separator bell. This device causes steam to make three changes in direction before passing into atmosphere, and includes a drain for condensed moisture into body. Escape of vapor into air thereby minimized. Separator bell also helps to keep spring cool by preventing steam from striking spring. Correct alignment of stem is maintained by precision machine work and by top guidance of stem in two bearings.
MADE BY — *Farris Engineering Co., Palisades Park, N. J.*

Tankless Taco

NAME—Type H. T. tankless Taco.
PURPOSE—Instant type heater for large volume hot water heating in apartment houses, smaller institutions, 2-family dwellings and other multiple room buildings.
FEATURES—Device is installed below water line of boiler with boiler water surrounding tubes through which service water flows. Can be used with steam or hot water boiler. May be used successfully without circulator but maximum capacities will be attained by addition of a circulator. Not recommended for use in localities with excessive amount of lime in water except where provision is made for cleaning heater or where water softener is installed.
SIZES AND CAPACITIES — Eight sizes with capacities from 175 to 900 gallons per hour of water heated from 40F to 140F with boiler water at 180F, or 350 to 1530 gallons with boiler water at 212F.
LITERATURE AVAILABLE — Data sheet 60-44.
MADE BY—*Taco Heaters, Inc., 342 Madison Ave., New York 17, N. Y.*

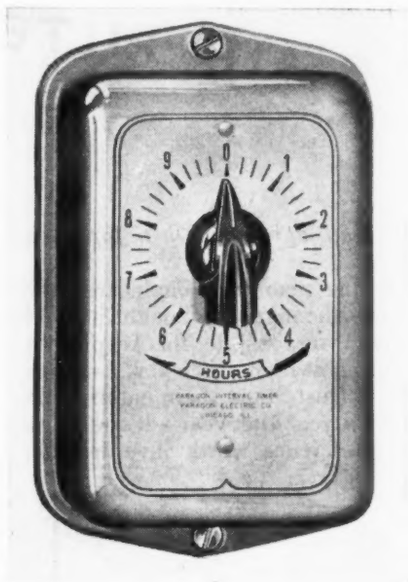
Binks Type B Cooling Tower

NAME—Binks type B forced draft cooling tower.
PURPOSE — For small and medium capacity water cooled condensers up to 20 ton capacity, especially for packaged air conditioning and refrigeration installations.
FEATURES — Conventional high speed propeller type fan has been replaced by slow-speed quiet-operating blower assembly. Air-water ratio has been greatly increased. Towers suitable for either indoor or outdoor use. For former, standard belt guard is furnished; for latter, power unit canopy

is suggested to protect blower and motor from elements.
SIZES AND CAPACITIES—Available in 5 sizes with capacities from 3 to 60 gpm and for installations from 1 to 20 tons of refrigeration based on 3 gpm per ton for a 10F rise.
LITERATURE AVAILABLE—Bulletin 700.
MADE BY — *Binks Mfg. Co., 3114-40 Carroll Ave., Chicago 12, Ill.*

Industrial Timer

NAME—Model 2500 pre-set industrial timer.
PURPOSE — Can be pre-set to allow given operation to continue for almost any pre-determined time limit and to close or open a circuit at the end of pre-set time. Adapted for use in processing applications, blower and pump operations, and control of



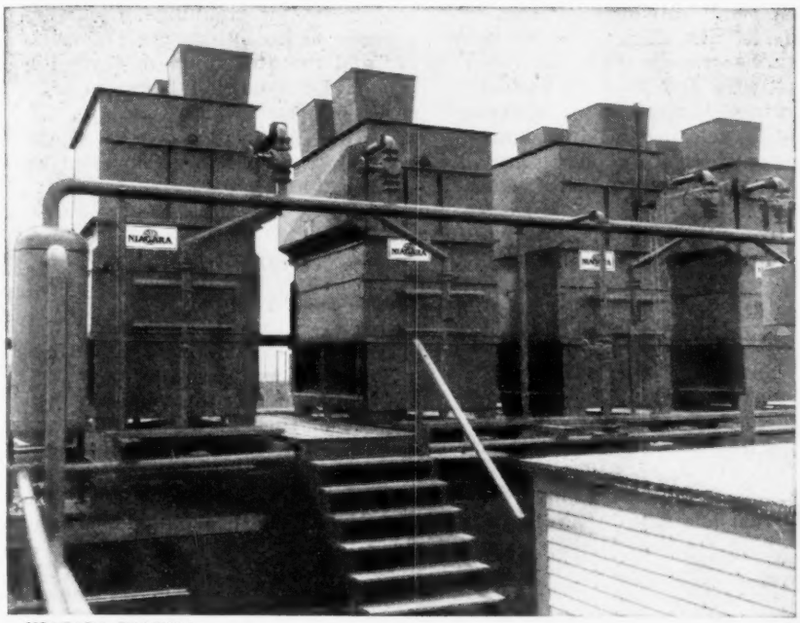
ventilating fans on a pre-set schedule with night heating shut down.
FEATURES—Single pole, double throw 1000 watt switch. Self-starting, slow-speed synchronous, completely-sealed motor. Rust proof.
SIZES AND CAPACITIES—Has ten times ranges from 0 to 15 seconds through 0 to 20 hours. Overall dimensions are 4⅞ in. high, 3 1/16 in. wide, 2 in. deep.
LITERATURE AVAILABLE—Bulletin 4492.
MADE BY—*Paragon Electric Co., Chicago, Ill.*

3-Inch Stroke Pump

NAME—Aldrich-Groff pump.
PURPOSE—An addition to the company's line of controllable capacity pumps and covering a 3 in. stroke, 20 hp unit.
FEATURES—Primarily used for boiler feeding, desuperheater feeding, pipe line, process charging and proportioning, these pumps are installed where automatic control of delivery is important. Operated at constant speed, from no-load to full rated capacity, power consumption is practically proportional to discharge.
LITERATURE AVAILABLE—Data supplement 65.
MADE BY—*Aldrich Pump Co., Allentown, Pa.*

INCREASED REFRIGERATION CAPACITY

+ CONDENSER WATER SAVINGS
+ POWER SAVINGS



NIAGARA PATENT

Large users of refrigeration have reduced operating costs by thousands of dollars thru power savings, thru savings of condenser water and by obtaining extra capacity.

These savings are made by the NIAGARA DUO PASS *AERO* CONDENSER using outdoor air as the cooling and condensing medium for refrigerant gases, reducing compressor head pressure.

Only the patented NIAGARA DUO PASS assures these gains because no other evaporative condenser lowers condensing temperatures to the point where deposits do not accumulate on outside of condenser tubes. This eliminates shut-downs for cleaning and assures full condensing capacity at all times. Write for Bulletins 91 and 93. Address Department HV-15.

NIAGARA BLOWER COMPANY

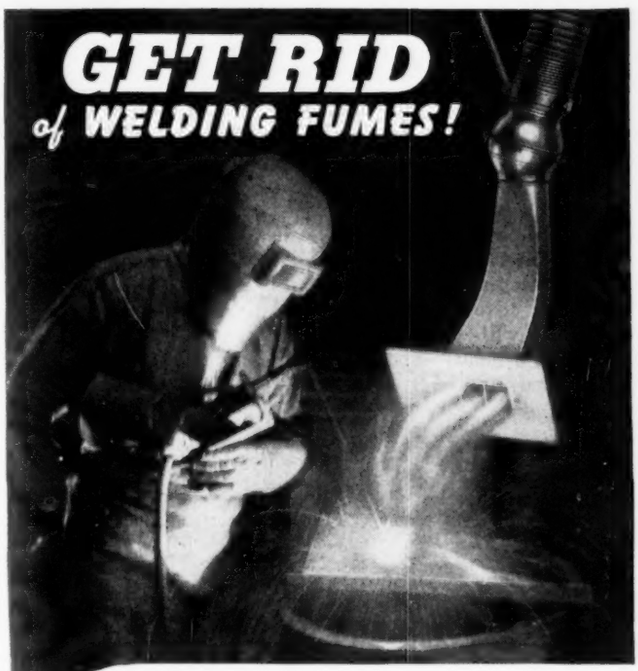
"30 Years of Service in Air Engineering"

6 E. 45th Street, New York-17, N. Y.

Field Engineering Offices in Principal Cities

NIAGARA *INDUSTRIAL* COOLING • HEATING • DRYING
HUMIDIFYING • AIR ENGINEERING *EQUIPMENT*

GET RID of WELDING FUMES!



The powerful suction created by Ruemelin Fume Collectors draws out noxious gases, smoke and heat *at the source. Cleans shop air with minimum loss of building* heat. Covers maximum territory. Guards employee health. More than 1,000 serving war plants all over the nation. Shipped completely assembled, easy to install.

Write for Bulletin 37-C

RUEMELIN MANUFACTURING CO.

3898 N. PALMER STREET MILWAUKEE 12, WIS.

Manufacturers and Engineers, Sand Blast and Dust Collecting Equipment, Welding Fume Collectors

NOW YOU CAN WELD GALVANIZED IRON AND STEEL

sheets, shapes and pipe and leave all surfaces

100% RUST and CORROSION PROOF

by regalvanizing the seams and joints with the

GALV-WELD PROCESS

Obsoletes Riveted, Bolted Construction

- Easy to use
- Fast
- Permanent
- No Flux Required
- No Fumes
- No Sandblasting
- Cannot be pried or peeled off.
- Applied in any position and in confined quarters.
- Economical.

Production-proved in wartime service, Galv-Weld Alloy (Reg. Trademark) has withstood all government tests, and is equal to and/or better than hot dip galvanizing in corrosion resistance. The bond to the base metal is superior to zinc metal spray.

Especially applicable in the case of sheet metal ducts and refrigeration units.

GALV-WELD PRODUCTS

314 W. 1st St., Dayton, Ohio

Please send, without obligation, information on Galv-Weld Process and sample of Galv-Weld Alloy.

Name .....

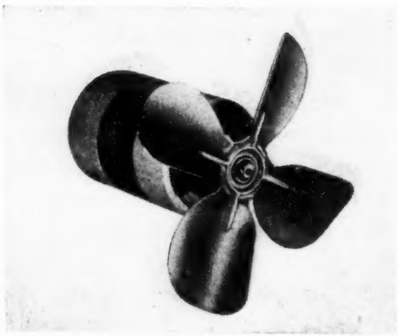
Firm .....

Street .....

City .....

Axial Flow Blower

NAME—Model J-80-A axial flow blower.
FEATURES—Has a free air delivery of 170 cfm by NEMA code, 65 cfm by NAFM code. Motor is 60 cycle, 115



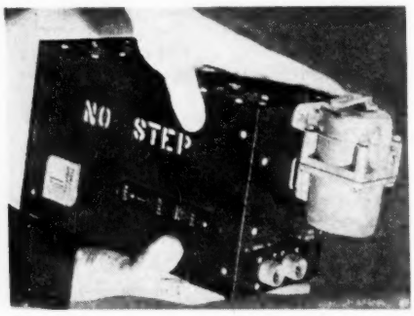
volt, single phase, 3100 rpm, 12 watts input, 1 oz. in. starting torque. Requires 1 mfd. condenser. Fan is 4 blade propeller type, 4 in. diameter.
MADE BY—*Eastern Air Devices, Inc., 585 Dean St., Brooklyn 17, N. Y.*

Lab Aprons

NAME — Laboratory and industrial aprons.
PURPOSE — For operations in laboratories, shops and so forth.
FEATURES—Made of high grade cotton fabric and vinyl resin coating which makes aprons waterproof, acid proof, alkali proof, oil and grease resistant.
SIZES AND CAPACITIES—Two sizes, one 35 in. wide by 45 in. long and the other 29 in. wide by 35 in. long.
MADE BY — *The B. F. Goodrich Co., Akron, Ohio.*

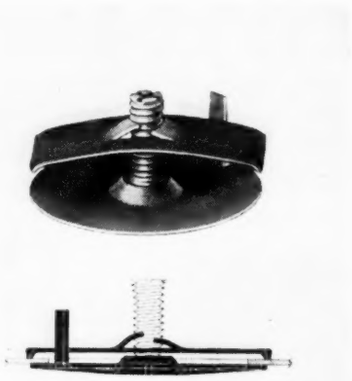
Plane Control

NAME — M-H electronic temperature control system for planes.
PURPOSE—Controlling temperatures in airplane cabins.
FEATURES — Packaged unit weighing under 8 lb designed automatically to hold any cabin temperatures selected by the pilot. Connected to master control switch in cockpit which automatically turns on when pilot starts engines. System includes outside air compensator to anticipate air temperature fluctuations. Compensator is a small coil of wire installed in outside air duct. Temperature fluctuations change electrical resistance of wire and in turn activates tubes which control motor opening, opening or closing mixing damper controlling ratio of outside to heated air. Also includes cabinstat (thermostat).
MADE BY — *Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.*



Cover Plate

NAME—Speed nut cover plate.
PURPOSE—For patching holes in sheet metal or for making removable covers for inspection doors, access doors and vents.
FEATURES — Easily and quickly attached from one side by sliding one



end of the nut into the hole, centering cover plate over hole and tightening screw. Turned-down tab on cover plate prevents nut from turning while screw is tightened. Made of SAE 1060 steel, heat treated, Parkerized and coated with zinc chromate primer.
SIZES AND CAPACITIES — 3 sizes for holes 29/32, 1⅛ and 1⅜ in. diameter. Other sizes are specially ordered.
MADE BY—*Tinnerman Products, Inc., 2010 Fulton Rd., Cleveland 13, Ohio.*

Withholding Tax Chart

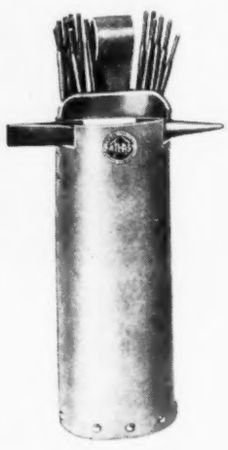
NAME—Delbridge simplified withholding tax chart.
PURPOSE—For determining amount of withholding tax.
FEATURES—Published in four editions covering weekly, bi-weekly, semi-monthly and monthly payroll periods. Each edition also shows daily miscellaneous deductions for periods from 1 to 6 days, inclusive. Chart also covers the 18 and 22.5% rates. Chart is an efficient visible index, hinged card type with large, clear print and with three line groupings of answers. Number of exceptions are printed in red and repeated for each three line group. Each edition has 16 hinged cards, base size 6½ x 9½ in.
MADE BY—*Delbridge Calculating Systems, Inc., 2502-10 Sutton Ave., St. Louis 17, Mo.*

Heat-O-Meter

NAME—Heat-O-Meter.
PURPOSE — A control for regulating operation of commercial stokers and oil burners.
FEATURES — With this control, percentage of time burner operates and frequency of operation is regulated in accordance with outside temperature and weather conditions. Can be adjusted to provide almost any operating cycle.
MADE BY—*Miller Heat-O-Meter Co., 4385 N. Green Bay Ave., Milwaukee 12, Wisc.*

Electrode Carrying Case

NAME—Atlas Dual-Case.
PURPOSE—For carrying welding electrodes and weld cleaning tools.
FEATURES — Preventing scrapping of welding electrodes due to cracked and chipped flux coating, caused by having them strewn over the floor, case is designed to carry supply of electrodes suspended from welder's belt. Extra division is provided for carrying weld cleaning tools.
SIZES AND CAPACITIES—12 in. high, 3½ in. in diameter, capacity 8 to 10 lb. of electrodes.
MADE BY—*Atlas Welding Accessories Co., 14824 Wyoming Ave., Detroit 21, Mich.*



Save Fuel- Heat Uniformly, Efficiently

with

AIRTHERM

COPPER COIL, STEAM

UNIT HEATERS

For Vertical Delivery

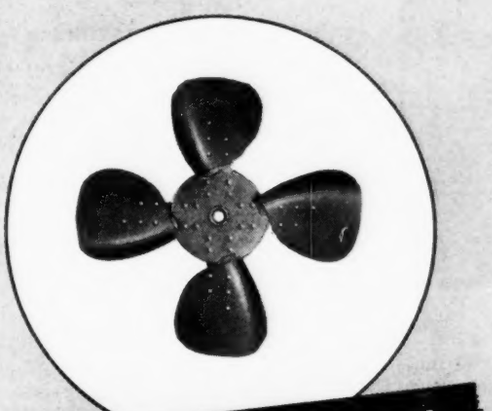
For Horizontal Delivery

Airtherm Steam Unit Heaters are now equipped with copper coils for longer life, durability, and resistance to corrosion. They are individually controlled to afford you efficient, economical operation.

Deflectors are designed so that air velocities are increased without the necessity of extra power. Air is distributed evenly from the fans through the condenser eliminating "dead spots" and guaranteeing you full efficiency from every ounce of steam expended.

Let us show you, too, how Airtherm Unit Heaters can heat uniformly, efficiently, with a saving in fuel cost. Write today for bulletin showing detailed specifications on the complete line of Airtherm Unit Heaters.

AIRTHERM
MANUFACTURING COMPANY
722 South Spring Avenue • Saint Louis 10, Missouri

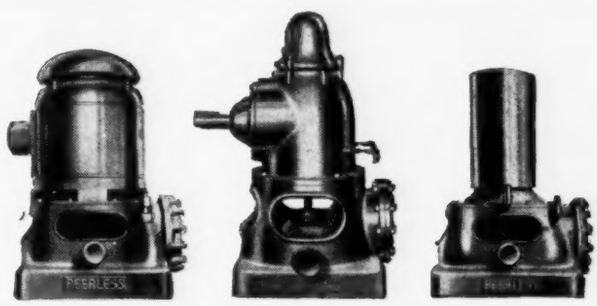


A NEW ATTIC FAN

For the first time, a completely new line of fans for attic ventilation has been developed on aerodynamic principles. The fans of the "B" series line are available with 3, 4 or 5 blades in the standard diameters of 24, 30, 36, 42 and 48 inches. Geometric proportions remain the same throughout the entire line.

AIR IMPELLERS *for every purpose*

THE TORRINGTON
MANUFACTURING COMPANY. TORRINGTON. CONN.



MOTURBO GEARTURBO BELTURBO

Peerless-pumped water pays daily dividends

WATER is usually considered industry's cheapest commodity—but too frequently it costs more than it should. Lowered efficiencies increase power bills. Pump breakdowns are costly, not only for repairs but in interfering with production. Now, with the installation of a Peerless pump, three objectives are accomplished: (1) Water is pumped at the lowest cost; (2) Because of the exclusive engineering design, construction and fine workmanship of the bowl and impeller assembly, *original efficiencies* are closely maintained over a greatly extended performance period, far beyond normal; (3) Pump repairs are reduced to the minimum.

ARMY E NAVY
PEERLESS PUMPS

PEERLESS PUMPS

PEERLESS PUMP DIVISION
Food Machinery Corporation

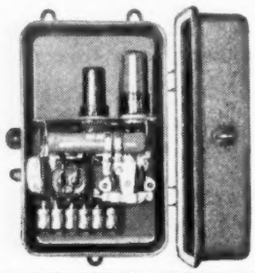
TURBINE
HI-LIFT
HYDRO-FOIL

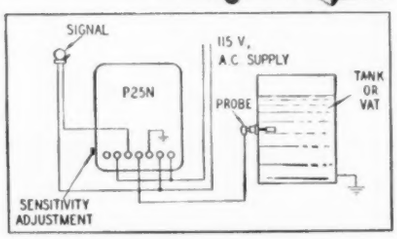
301 W. Ave. 26, Los Angeles 31; Calif. • 1250 Camden Ave. S.W., Canton 6, Ohio • Other Factories: San Jose 5, Fresno 16, Calif.

Concentrate Control

NAME—Electronic concentrate control.

PURPOSE—For detecting and controlling, through operation of signals, valves or pumps, changes in liquid concentrations.





FEATURES—Installation requires only that a probe fitting be mounted on the tank with probe extending into liquid. Probe is wired into electronic control which may be located wherever desired. Typical application is detection of contamination in boiler condensate. A large smelting company, for example, uses condensate to heat coils containing an acid electrolyte. As a leak in coils permits acid to mix with condensate and renders it unfit for return to the boilers, it is necessary to detect and control such leakage. Addition of acid to water increases its conductivity and this change is detected by electronic control. An alarm is sounded and a three-way motorized valve operates to remove contaminated condensate.

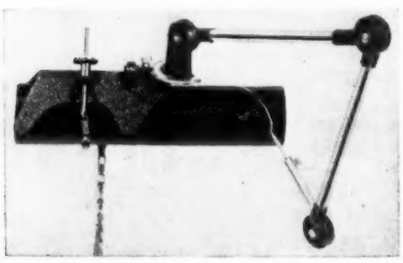
MADE BY—*Photoswitch Inc., 77 Broadway, Cambridge 42, Mass.*

Pipe and Sheet Protractor

NAME—Trumark Protractor.

PURPOSE—For scribing, preparatory to cutting, any angle within ½° on sheets, pipe or shapes.

FEATURES—Made in two stock models, three sizes. Model illustrated scribes circumference of pipe 3 to 18 in. in diameter. Is placed on the pipe parallel to center line, leveled by a built-in spirit level, locked in place with spring chain, adjusted to desired angle by 180-degree scale, and the scribing completed. Protractor is made of cast bronze alloy and steel tubing. Marking arm is rigid throughout its travel. Another size of this model marks pipe 12 to 36 inches in diameter. A junior model marks pipe or rod ½-inch to 3 in. in diameter. Last is of sturdy accurate die cast construction.



MADE BY—*Tru-Line Corp., 759 Venice Blvd., Los Angeles 15, Calif.*

Welding Unit

NAME—Westinghouse 200 ampere d.c. welder.

PURPOSE—A lightweight welder designed for portability such as for aboard ships.

FEATURES—Unit weighs 333 lb as compared to 500 lb for a 150 ampere conventional welder, a one-third decrease in weight with a one-third increase in capacity. Much of weight reduction comes from vastly improved ventilating system.

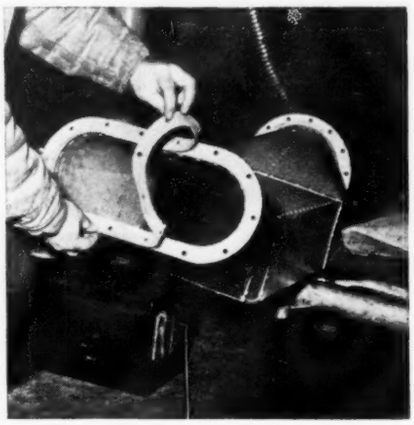
MADE BY—*Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.*

Chromate Gaskets

NAME—Chromate gaskets.

PURPOSE—Originally intended as a substitute for low pressure gaskets in marine ventilating systems, but has since been found useful in other applications including seals for water, fuel oil and diesel oil systems and refrigerator doors.

FEATURES—Consists of a felt base, impregnated with a chromate pigmented compound which renders the material flame and fire-resistant as well as corrosion resistant. Chromate gasketing is flame and fire resistant to high degree, can withstand relatively prolonged exposure to salt water without decomposition. It may be had either factory pre-cut or cut from sheet at the point of use without special tools. Will maintain air pressures up to 25 lb per square inch at normal temperatures. Not affected by fuels and has definite rust inhibiting properties.



SIZES AND CAPACITIES—Dark green in color, available in two thicknesses, ⅛ in. and 1/16 in.

MADE BY—*Sherwin-Williams Co., 101 Prospect Ave., N.W., Cleveland 1, Ohio.*

Thread Protectors

NAME—Precision thread protectors and dust caps.

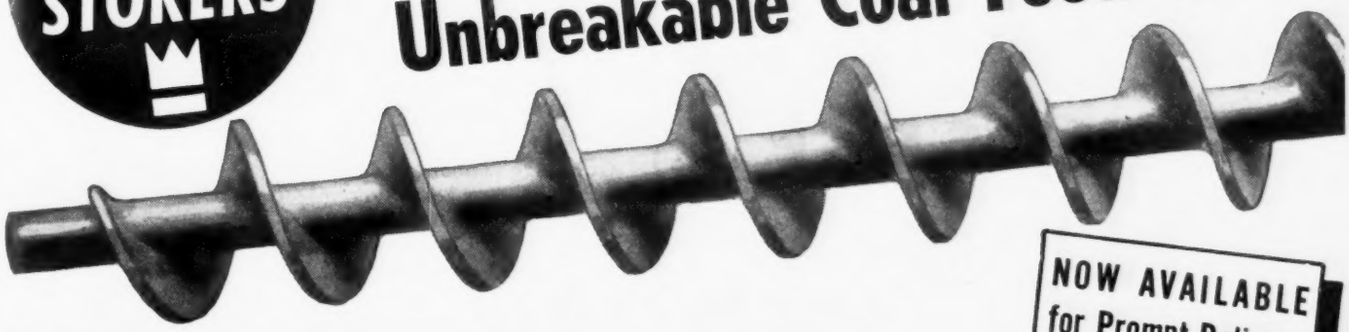
PURPOSE—Internal and external safeguards for threaded machine parts and fittings.

FEATURES—Made of spiral-wound fibre, kraft paper, or cellulose acetate, under heat-treated compression. Designed and constructed for greatest durability in protecting fittings, exposed openings and ends, tubing from moisture, rust, dirt, grit, dust or damage in packing, storage or shipping. Protectors are shaped to the article to be safeguarded, cylindrical, square, rectangular or tapered, crimped, flared or perforated, with tolerances as close as .003 in. Name of part and number, as well as name of manufacturer, can be printed on the protector.

MADE BY—*Precision Paper Tube Co., 2033 W. Charleston St., Chicago 47, Ill.*

For STOKERS

The CROWN Unbreakable Coal Feed Screw



NOW AVAILABLE for Prompt Delivery

WELDED All-Steel Worm—All Sizes—All Pitches

★For replacement or production needs, Crown is now able to offer for prompt delivery its all-steel Coal Feed Screw. Available with right or left hand screw, in all sizes and pitches, tapered or straight, and in combinations of pitches. For both domestic and industrial stokers, the Crown Coal Feed Screw insures longer and continuous operation because it is all-steel and because it is machined so smoothly that wear is reduced to a minimum. This smooth surface is your assurance, too, that coal will flow freely and easily through the flights. Prompt delivery is possible because production requires less time on Crown's automatic machines and because the steel used in Crown's Coal Feed Screw while critical, is more easily procured.

In ordering give complete specifications on size and design.

CROWN IRON WORKS COMPANY

1229 Tyler St., N. E. *Since 1878* Minneapolis, Minn.

Don't Let SLIME DEPOSITS CLOG Your Air Conditioning Units!

DO you want to control formation of slime deposits in your air conditioning equipment? Then add recommended amount of Oakite Airefiner to your recirculating water supply. It will combat slime, stop clogging of drains, piping, spray heads, pumps.

Clean, Then Treat System!

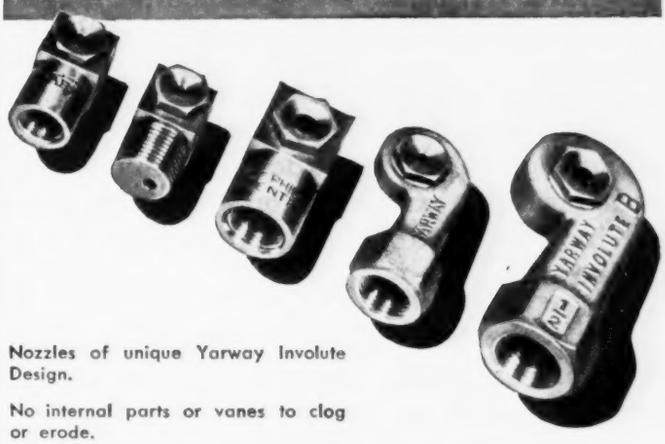
But before doing this, make certain that entire system is CLEAN! An effective, economical method is to circulate solution of Oakite Composition No. 22 which speedily removes sludge and other foreign matter. Then, after draining and rinsing, add Oakite Airefiner as directed. The results will speak for themselves! Write for FREE booklet giving complete details!

OAKITE PRODUCTS, INC., 58A THAMES ST., NEW YORK 6, N. Y.

Technical Service Representatives in All Principal Cities of the United States and Canada

OAKITE MATERIALS METHODS SERVICE — Buy Bonds for Victory — CLEANING FOR EVERY CLEANING REQUIREMENT

AIR CONDITIONING NOZZLES



Nozzles of unique Yarway Involute Design.

No internal parts or vanes to clog or erode.

Insure trouble-free air washing service.

Sizes and types for all requirements.

Many large users — installations total more than 5 million gallons per minute in water cooling and air conditioning service. Write for Bulletin N-616.

YARNALL-WARING COMPANY
104 MERMAID AVENUE
PHILADELPHIA 18, PA.

YARWAY

ESTABLISH YOURSELF NOW

with a complete line of modern-design Heating and Ventilating Equipment

THE Johnson Fan and Blower Corporation—for 26 years manufacturers of a complete line of Propeller Fans, Blowers and other ventilating and heating equipment—has available a few choice territories for experienced manufacturers' representatives.

The latest types of Johnson Fans and Blowers, designed for exacting Army, Navy and Maritime Commission requirements, are now available to commercial and industrial users.

If you can add a line of this kind to your present business and do an effective selling job now and in the post-war years, please write us in detail about yourself, addressing:

THE JOHNSON FAN AND BLOWER CORP.

1321 West Lake St. ★ Chicago 7, Ill.

Getting Personal

George H. Krueger

George H. Krueger, author of this month's blueprint section on Electrothermal Space Heating and Air Conditioning, page 67, was born in Denver, Colo., and attended secondary schools in Pueblo, Colo.

Unlike most boys who go from high school to college, he served a four-year apprenticeship as a boilermaker before entering the University of Colorado where he received his M. E. degree.

Following graduation he was employed as construction engineer in power plant wor for the Colorado Power Co., and the Great Weste Sugar Co. In 1917 he joined the engineering staff of th Seattle Construction and Dry Dock Co., and remaine there for 4 years.

Mr. Krueger opened a consulting engineering offic in Seattle to carry on the practice of power plant de sign and construction. Projects included mill powe plants, central heating systems, power plants and unde ground heating systems. The office was maintained u til 1935.

At that time he joined the engineering staff of th Zellerback Paper Corp., as engineer in charge of stea and hydraulic design. Five principal mills were d signed and constructed.

Following the pulp mill program, he designed th high pressure steam power plant for the Puget Soun Navy Yard at Bremerton, Wash.

In 1940, he joined the engineering staff of the Bo neville Power Administration as mechanical engine and he still retains that post.

Elmo Hall

Elmo Hall (Answers to Radiant Heating Questions, page 57) was born in Kansas and received his education in Chicago. He was a member of the National Guard and saw service at the Mexican border.

His professional background includes a period up to 1929 when he was active as a construction engineer and general contractor. For the next ten years, Mr. Hall served as a heating and combustion engineer with the American Gas Products Corp., with assignments in both the Unite States and Mexico. Since 1939, he has been the owne manager of the Empire Gas & Equipment Co., Denve In 1941 he started manufacturing gas furnaces and a conditioning units, but this was halted by the war. Sin 1941 his principal activity has been consulting engine for large army camps.

His principal worry is to have his tailor say, "Sor we do not have 48. You will have to take a 46 and will let it out for you."

Mr. Hall has two hobbies—digging Indian ruins, a radiant heating. He has two sons, one a chemical e gineer now in Persia and the other still at college.

NEW CATALOGS

Filters

A standard size, 8-page bulletin entitled Staynew Liquid Filters for Oils, Water, Chemicals, Etc.—*Dollinger Corp., 11 Centre Park, Rochester 14, N. Y.*

Deaeration

Reprint 36 describing application and general design of cold water deaerators to prevent corrosion of pipe lines and heat exchange equipment.—*Cochrane Corp., 17th & Allegheny Ave., Philadelphia 32, Pa.*

Filters

Custom-designed permanent filters and weatherhoods to fit all standard generator welders are illustrated and described in a four-page folder. According to the manufacturer, the Badger filter when installed on a generator welding unit effectively stops process and atmospheric dust, grit, mill scale, welding slag, foundry sand and other particles harmful to moving parts. The folder announces a re-design of the Badger filter, and the results of research and test in welding shops throughout the country. It illustrates developments for use on all standard makes of welding machines and introduces the Badger Weatherhood. Snap-locked to position on the filter unit, the Weatherhood is designed for outside installations or where welders are subject to heavy moisture. It is claimed that the hood keeps snow, sleet, rain or atmospheric and salt moisture out of the machine interior by means of an exclusive design. — *Badger Corporation, 326 East Brown St., Milwaukee 12, Wis.*

Valves and Controls

An 8-page descriptive catalog giving detailed information and data on the company's line of Cash-Acme automatic valves and pressure controls for water, air, steam and oil.—*A. W. Cash Valve Manufacturing Co., Decatur, Ill.*

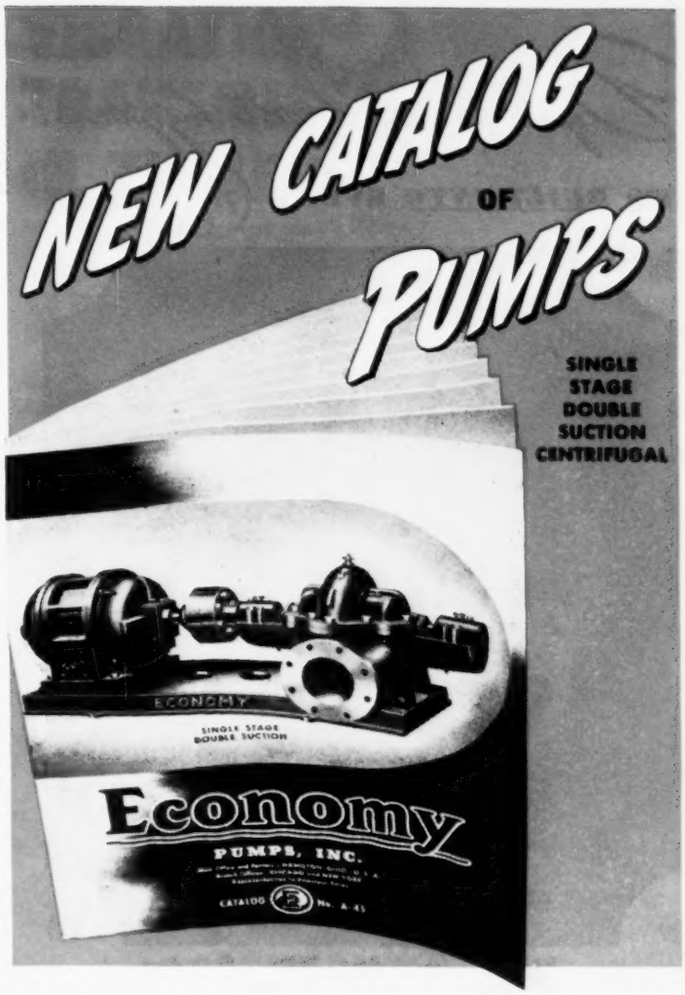
Leather Belting

A 56-page, standard size, leather belting selection and application manual which is said to provide a simple, non-technical approach to a subject that frequently is permitted to become involved. Manual offers data, charts, and specifications to support following headings—how to pick the right leather belt for job, including information on tannages, figuring of belt dimensions; how to decide between modern group drive and automatic tension (pivoted motor base) drive; how to compare efficiency and cost of multiple V-belt drives and flat leather automatic tension drives; how to figure flat leather belt prices; how to install flat leather belts properly; how to make bolts deliver more power and last longer. Includes a brief catalog section of leather belting and accessories. —*Graton & Knight Co., Worcester 4, Mass.*

Blowers

A four-page general bulletin, G-81-D, covering company's rotary positive blowers and gas pumps, centrifugal blowers and exhausters, rotary positive vacuum and liquid pumps, rotary displacement gas and liquid meters, and inert gas generators. Typical installation views are shown covering principal application.—*Roots-Connersville Blower Corp., Connersville, Ind.*

(Continued on page 110)



Now Ready!

- NEW FEATURES OF DESIGN
- NEW PERFORMANCE ACHIEVEMENTS
- NEW SIZES AND CAPACITIES
- NEW APPLICATIONS

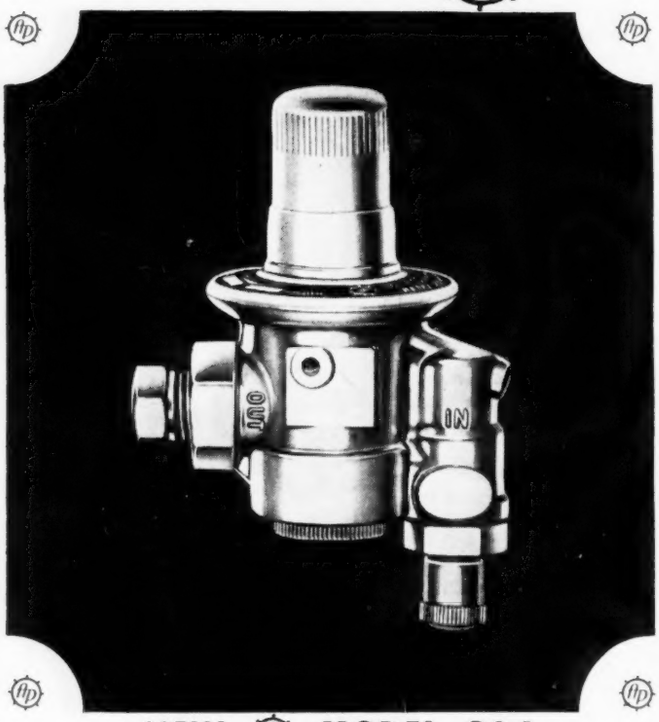
Catalog A-145, just off the press, covers an entire range of Centrifugal Pumps, especially engineered for industrial, municipal and other water supply systems. Cross-section illustrations, performance curves and structural details show at a glance why users of Economy Pumps save in cost, power, labor. Selection tables simplify the choice of exact types and sizes to handle specific requirements. A copy of the catalog is yours for the asking, on your letterhead. So are the services of our engineering staff—for special problems—without obligation.

SEND FOR YOUR COPY TODAY!

ECONOMY PUMPS, INC.
HAMILTON, OHIO • U. S. A.
FOR OVER THIRTY YEARS MAKING BETTER PUMPS DO MORE

Dependability doesn't happen...

IT'S *BUILT INTO* EVERY AP VALVE



NEW AP MODEL 204
AUTOMATIC EXPANSION VALVE

A new design of a famous and popular A-P Valve, the new A-P Model 204 AUTOMATIC Expansion Valve has many new features for improved operation on domestic refrigerators, beverage coolers, serum cabinets, and similar applications. One of these new features is the moisture-proof metal cap, providing absolutely tight seal against air and moisture for protection against freeze-up in the head, yet offering ready access to the adjusting knob.

Compact, small in size, precision-built throughout, sturdy, sensitive and leakproof, Model 204 has an adjustable range of from 15" vacuum to 35 lbs. pressure. Rated at ¼ ton Freon and ½ ton Methyl Chloride and Sulphur Dioxide, it is designed for long-life, dependable service. For further details, write for Bulletin No. 407A.

AUTOMATIC PRODUCTS COMPANY

2462 North Thirty-Second Street • Milwaukee 10, Wisconsin

Export Dept.—13 E. 40th St., New York 16, N. Y.

AP

DEPENDABLE
REFRIGERANT VALVES

Stocked and sold by progressive refrigeration jobbers everywhere... Recommended and installed by leading refrigeration service engineers

(Continued from page 109)

Switches

A 16-page, standard size catalog, devoted to the company's line of Asco electrically-operated switches, remote control switches, contactors, relays, and solenoids.—*Automatic Switch Co., 41 E. 11 St., New York, N. Y.*

Controls

Bulletin DM012, a 6-page standard size folder, devoted to the company's model 93 air operated controllers for heating and cooling applications and involving the control of steam, gas, oil, or refrigerants.—*The Bristol Company, Waterbury 91, Conn.*

V-Belts

A conversion chart and price list for fractional horsepower V-belts. Gives size and conversion data on standard O, A, and B section belts.—*The B. F. Goodrich Company, Akron, Ohio.*

Hole Punching

Catalog CD of 32 illustrated pages in color to explain and describe a hole punching system. The system is made up of Wales CD hole punching units, templates, locator rings, adjustable stops, feed rails and drill templates.—*Wales-Strippit Corp., North Tonawanda, N. Y.*

Multiple V-Belts

A 16-page, small size booklet, arranged in primer style and devoted to multiple V-belt traps and entitled "19 Reasons Why it is the Dominant Drive of Industry."—*Multiple V-Belt Drive Assn., 140 S. Dearborn St., Chicago, Ill.*

Temperature Control

An elaborate 40-page, standard size catalog in color entitled "Fenwal Thermoswitches" and devoted to the company's line of temperature control devices for use in applications for sub-zero to 2000F and including a section on the general theory of the Electroswitch and other sections devoted to the following type switches: Cartridge, flange heat, block head, hex head, air limit control, hot water limit control, all-purpose thermostats, flame control and other devices.—*Fenwal Incorporated, Ashland, Mass.*

Roof Ventilators

A 2-page, single sheet bulletin devoted to the company's Windmotor rotary suction ventilator and giving descriptive and capacity data.—*Airecon Industries, 2536 Fourteenth St., Detroit 16, Mich.*

75 Years of Progress

In "Circuits for Victory," a 40-page booklet in color is presented a history of the Western Electric Co. The picture method is used to tell the story. Included are a series of paintings in four colors to show three dramatic events in telephone history.—*Western Electric Co., 195 Broadway, New York 7, N. Y.*

Unit Heaters

A 4-page, standard-size, loose-leaf punched bulletin devoted to Acofin suspension type unit heaters. Includes illustrations, descriptions and capacity data.—*Aireco Industries, 2536 Fourteenth St., Detroit 16, Mich.*

Motors

Data sheet 6-1, page 53, standard size, loose leaf punched, single sheet, devoted to the company's explosion proof motor, class 1, group C, for ethyl ether vapor applications.—*Century Electric Co., St. Louis 3, Mo.*

. . . Since the Last Issue

Appointment of **J. J. Anderson** as Eastern district supervisor of the refrigeration specialties department of **Westinghouse Electric and Mfg. Company** has been announced. Mr. Anderson is located at the Company's Eastern district headquarters at 40 Wall Street, New York. Mr. Anderson has been with Westinghouse since 1937. Since completion of the Company's student training course, he has served as air conditioning supervisor in the Central district and from 1941 to 1944 has been in the war products department of the Company. In his new capacity, Mr. Anderson will be responsible for the sale of the products of the refrigeration specialties department in the Eastern district, comprising New England, New York State and Northern New Jersey.

Milcor Steel Company, Milwaukee, through C. G. Wollaeger, vice-president in charge of sales, announces that **J. Howard Riddle,** who has been in charge of the Milcor Rochester branch since 1938, has been assigned new duties in connection with special sales work. He will remain in Rochester. His services on merchandising problems will be available to the trade. **Frank C. Raschka** has been appointed to take Mr. Riddle's place as manager of the Rochester branch. Mr. Raschka has been with Milcor for many years.

Frank C. Raschka

Spoehrer-Lange Company, 3723 Commonwealth Ave., St. Louis, Mo., has changed its name to **Sporlan Valve Company.** The purpose of this change is to make the company name conform with the trade name Sporlan under which it has manufactured control devices for refrigeration and air conditioning for the past eleven years. The change in name in no way affects the policies, management, organization or financial structure of the company.

General Meters & Controls Co., 205 West Wacker Drive, Chicago 6, Ill., has been appointed district representative for northeastern Illinois and northwestern Indiana by the **American District Steam Company,** North Tonawanda, N. Y.

The Trane Company announces enlargement of its Centrifugal Class I Fan line for the post-war period. Wheel diameters will run from 4½ to 89 in.; capacities up to 330,000 cfm. Fans will be available in any standard drive arrangement and direction of discharge. When fan diameters are 15 in. or more, either forward curved or backward inclined fan blades can be obtained. Forward curved blades are available on fans less than 15 in. in diameter. Previous to announcement of the enlarged line, fans ranged up to 66 in. wheel diameter.

Drayer & Hanson, Inc., Los Angeles, Calif., has leased the building at 767 East Pico Blvd. The new quarters will house the purchasing, sales and advertising departments as well as facilities for fabrication of certain products.

(Continued on page 112)

VIBRATION TRANSMISSION IN THESE BUILDINGS HAS BEEN STOPPED by KORFUND

VIBRATION CONTROL

Vibration transmission from air-conditioning and ventilating equipment can be a constant source of annoyance—destroying comfort and impairing human efficiency. Here is a list of prominent buildings in which Korfund Vibration Control has solved this problem.

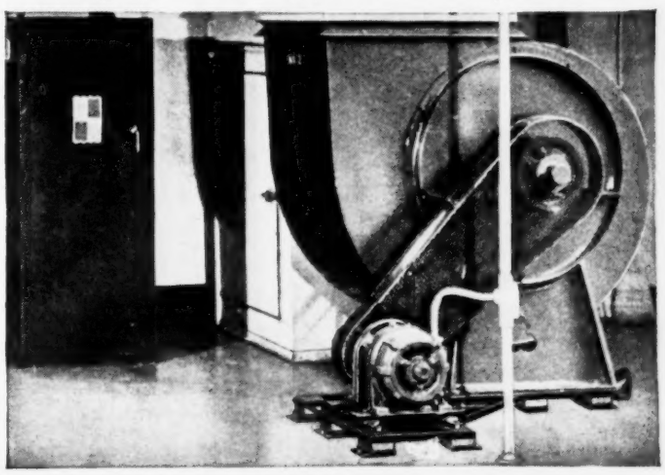
L. Bamberger & Co., Newark, N. J.
California Institute of Technology, Pasadena, Cal.
Chalfonte-Haddon Hall, Atlantic City, N. J.
Dept. of Justice Building, Washington, D. C.
Eastman Kodak Co., Rochester, N. Y.
Hotel Pierre, New York City
Indiana State Library, Indianapolis, Ind.
Michigan Bell Telephone Co., Detroit, Mich.
Mt. Sinai Hospital, New York City
Museum of Art, Philadelphia, Pa.
Palmer House, Chicago, Ill.
S. H. Kress Stores
U. S. Capitol Building, Washington, D. C.
U. S. Supreme Court Building, Washington, D. C.
U. S. Treasury Building, Washington, D. C.
University of Pittsburgh, Pittsburgh, Pa.
Waldorf Astoria Hotel, New York City

If you have a vibration problem, call Korfund. An experienced engineer will analyze your problem and specify the correct vibration control equipment for its solution.

THE KORFUND COMPANY, INC.
48-33 Thirty-second Place, Long Island City 1, N. Y.
Representatives in Principal Cities

Fans mounted on Korfund Natural Cork Seismo-Dampers "floating platform." This is an effective method of isolating air-conditioning equipment.

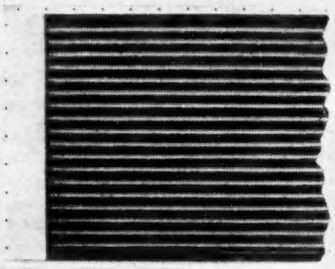
KORFUND VIBRATION CONTROL



McCORD
HEATING AND AIR CONDITIONING PRODUCTS

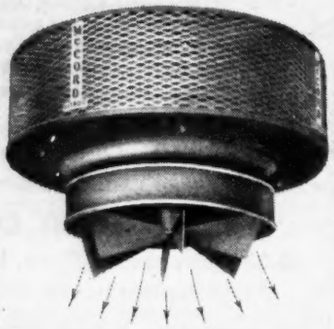
BLAST HEATING COILS
AIR CONDITIONING COILS
ALL TYPES

McCord spiral fin tube construction with the tubes formed or bent permits uniform expansion without strain. Headers are heavy wall construction with tubes brazed into extended ferrules formed in the headers. Fins are helically wound and metallically bonded.



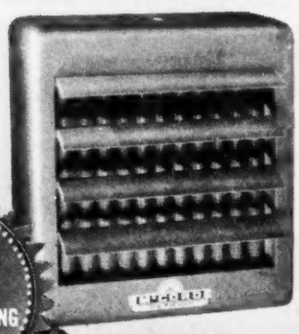
VERTICAL TYPE
UNIT HEATERS

A tried and proven heating unit, modern in design. McCord spiral fin tube construction creates air turbulence without undue restriction, thus increasing heat transfer capacity. Guaranteed for 150 lbs. saturated steam pressure. Nine models.



HORIZONTAL TYPE
UNIT HEATERS

Proven, rugged, modern design. Quiet, guaranteed for use on #150 p.s.i. steam pressure. Heating element, individual spiral fin tubes free to expand without strain on joints. Standard motors with standard bases used. Ten models.



YOU CAN DEPEND ON McCORD AIR CONDITIONING PRODUCTS

McCord RADIATOR & MFG. CO.
DETROIT II, MICH.

(Continued from page 111)

Viking Air Conditioning Corp., 5600 Walworth Ave Cleveland, has appointed the San Francisco export an import firm of **Polak, Winters & Co.** to represent it i South and Central America.

To reflect more accurately the business of the com pany, **Utility Fan Corporation**, Los Angeles, changed it name January 1 to **Utility Appliance Corporation.** Star ing in 1925 as a manufacturer of ventilating equipmen the organization now produces and distributes a wid range of air cooling, air moving, and gas-fired heatin appliances. More than five acres of floor space will b occupied in its Los Angeles plants.

Hoffman Specialty Company, Indianapolis, Ind., ha appointed **Neil D. Skinner** as executive vice-president, effective December 4, according to an announcement by Potter Bowles, president. Mr. Skinner was for eight years with the Red Jacket Mfg. Co., Davenport, Iowa, as general sales manager, and for eleven previous years with the Crane Company, being assistant to George Hoffman, manager of the heating and plumbing division, at the time of his leaving. Mr. Skinner is now planning Hoffman's 1945 sales an advertising program.

Neil D. Skinner

Sheffler-Gross Co., manufacturers representatives Philadelphia, is celebrating its 25th anniversary. Th company consists of three partners, **Mr. Sheffle S. Gross** and **T. J. Kenny**, the first two of whom forme the company after the first World War. The firm repr sents, among others, the Fulton Sylphon Co., Fish Governor Company, Cuno Engineering Corp., Rivet Lathe & Grinder, Inc., Buffalo Meter Company, Anem stat Corporation of America, American District Stea Co., R-S Products Corporations, Waterloo Register C and Badger Fire Extinguisher Co.

Consolidated Conditioning Corp., Mount Vernon, N. has appointed **Russell Tree**, formerly Northeastern di trict manager of Carrier Corporation, as president Consolidated, while **Ray Duncan** and **Lewis Wach** formerly sales engineers for Carrier, have joined t Consolidated sales staff.

Pullman, Inc., concluded on December 21 negotiatio for the acquisition of the outstanding stock of t **M. W. Kellogg Company**, petroleum and chemical en neers, in a move to broaden the activities of the co pany in the face of the pending severance of the c manufacturing and sleeping-car businesses. The acqui tion will be for an undisclosed amount in cash, with pri to be determined finally in accordance with conditio of the sales contract, it was announced jointly by D. Crawford, president of Pullman, and M. W. Kellog president of the engineering company. Mr. Kellogg h been elected a director of Pullman, Inc. The Kello company will be operated as "a separately incorporat member of the Pullman group of companies, with t present staff of officers and employes, and continui as a specialized research, manufacturing and engine ing-construction company along the lines which ha given Kellogg leadership in its field for more than quarter of a century."

Vaughn-G. E. Witt Co., and the Rucker Equipme Co., Oakland, Cal., have merged to form the **Ruck Vaughn Co.**, with offices at 300 17th St., Oakland, a the factory in Emeryville. **Martin R. Kennedy** represe the firm in Portland, Ore., and **J. C. Ross** in Seattle, Wa

Allen-Bradley Co., Milwaukee, Wis., has appointed **E. B. Dewey** as sales representative. Mr. Dewey's offices are in the American National Bank Building, Kalamazoo, Mich. He will cover Southwestern and Central Michigan and provide sales engineering service. Mr. Dewey was for fourteen years resident engineer for Century Electric Company. For the past four years, he has maintained his own office and represents several manufacturers of electrical equipment.

Returned to the United States by air from China after a serious injury and now recovering at Gardiner General Hospital in Chicago, is **Capt. Carl R. Embury**, Air Corps Ordnance, formerly an engineer in the Chicago office of the Freeman Stoker Division, Illinois Iron & Bolt Co. Capt. Embury is the holder of the Purple Heart, Air Medal and Soldier's Medal.

Acquisition of three new companies, expanding **Dresser Industries, Inc.**, to 13 members, has been authorized by Dresser directors. The companies to be acquired are the **Day & Night Manufacturing Co.**, Monrovia, Calif., **Payne Furnace and Supply Co., Inc.**, Beverly Hills, Calif., and **Kobe, Inc.**, Huntington Park, Calif. The acquisition will be accomplished by an exchange of stock and will be effected about Feb. 1, 1945, if approved by stockholders of the three companies. Day and Night manufactures gas-fired hot water heaters, Payne produces steel furnaces and floor furnaces, while Kobe is a producer of hydraulic deepwell oil pump systems.

Elgo Shutter & Manufacturing Co., Detroit, Mich., is, beginning January 1, again manufacturing its shutters of aluminum as in pre-war days. The company will continue its policy, adopted some years ago, of distributing its products exclusively through manufacturers of fans, blowers, exhausters and air conditioning equipment.

Charles Davies, formerly president of Davies Air Filter Corporation, is now specializing in industrial designing and product engineering, and has opened offices at 11 West 42nd St., New York 18.

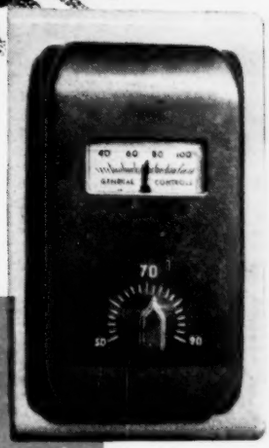
S. D. Mizell of Atlanta, Ga., manufacturers' representative and president of the Southeastern Travelers Club, has been appointed Southeastern sales manager of **Richmond Radiator Company**, it is announced by John J. Hall, vice-president and manager of sales. Mr. Mizell at one time conducted a plumbing and heating business of his own. For the last five years he has acted as agent for the Richmond Radiator in the southeastern sales territory. His offices will be at 422 East Wesley Road, N. E., Atlanta, Ga.

S. D. Mizell

Stimulated by the **Association of American Railroads'** announcement that shipping damages for non-enamelled furnaces, radiators, stoves, ranges and parts totaled $239,097 in 1943, manufacturers of wirebound boxes are experimenting with new containers to meet the problem. With the help of several package laboratories, they are creating containers to fit post-war needs and eliminate damage to products in shipping. They are consulting with manufacturers of furnaces, radiators and stoves on how they can avoid damage losses in designing, manufacturing and packing their products. As a result of present experiments and present consultations, the **Wirebound Box Manufacturers Association** believes it has the answer to the problem of cutting down damage losses in the shipping of these articles. The solution is a flexible, shock-resisting quality to shipping containers.

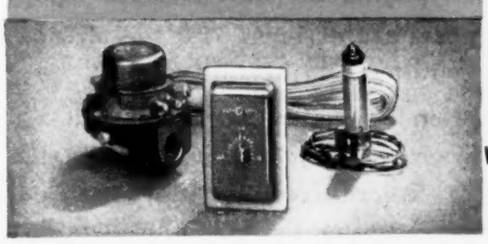
(Concluded on page 114)

Trimtherm



TOMORROW'S THERMOSTATS *today!*

- **T-80 SERIES** Trimtherm Thermostats are designed for all-gas control systems.
- **ACCURATE REMOTE CONTROL** of desired room temperatures.
- **SURFACE MOUNTING** with flush, streamlined appearance; no recess in wall.
- **1/2° DIFFERENTIAL** Without false heat input.
- **MODERN DESIGN** Harmonize with room appointments.
- **PLASTIC BASE** Thermally isolates thermostat from wall.
- **VISIBLE MARKINGS** All calibrations easily read.
- **ADJUSTMENT ON COVER** No wall smear.



AVAILABLE IN PACKAGE SETS

● T-80 SERIES THERMOSTATS are also available in Package Sets, together with B-60 gas control with tamper-proof cover and integral pilot valve assembly; 30 feet of wire; and thermocouple pilot generator. *Everything needed*, in a convenient package, for quiet, safe, automatic control of central and floor furnaces, boilers, radiators, gas ranges and water heaters.

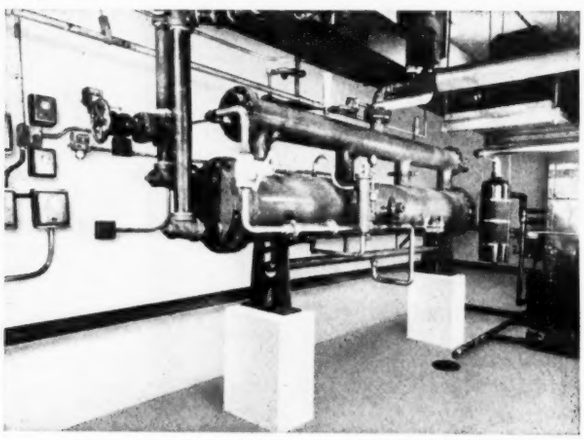
WRITE FOR CATALOG 52

GENERAL CONTROLS
801 ALLEN AVENUE GLENDALE 1, CALIF.
BRANCHES: Atlanta, Boston, Philadelphia, San Francisco, Denver, Chicago, Kansas City, New York, Cleveland, Detroit, Dallas
Distributors in Principal Cities

Typifying
PATTERSON-KELLEY
Service and Products

FREON COOLER

Flooded Type—50 Ton Capacity — Fin Tubes, Installed to Air-Condition Display Rooms of one of New York's Fashionable Millinery Shops.



This is one of the latest types of Patterson-Kelley Freon Coolers, typifying the heat transfer equipment our engineers are designing for the air conditioning, refrigeration and heating fields.

The use of a flooded system together with extended cooling surface considerably reduces the size of the cooler. Where a compact unit is needed, particularly due to space limitation, we suggest investigating this design.

Patterson-Kelley Engineers have broad experience in the field of heat transfer equipment. Designing and building coolers to meet today's problems is our specialty.

EST. 1880

THE PATTERSON-KELLEY Company, Inc.

Main Office and Factory
107 WARREN STREET, EAST STROUDSBURG, PA.

BOSTON 16, 96-A Huntington Avenue • NEW YORK 17, 101 Park Avenue
PHILADELPHIA 3, 1700 Walnut Street • CHICAGO 4, Railway Exchange Building
Representatives in all Principal Cities 1-PK-4

(Concluded from page 113)

O. B. Wilson has been named New York industria manager for the **Brown Instrument Company,** precisio industrial instrument division, Minneapolis-Honeywe Regulator Company. His appointment becomes effectiv the first of the year. He has been with the Brow company for 21 years, during which time he has serve in several branch offices throughout the country and a the company headquarters at Philadelphia. Mr. Wilso is being transferred from the Chicago branch, where h has been industrial manager for the past several years to the Honeywell New York office.

J. A. Robinson has been named industrial manage of the Chicago branch to succeed Mr. Wilson. Mr Robinson has been with the Brown organization 1 years, for the past several years with the Chicago branch

A charter recently granted **Designers For Industr Research Foundation** will make possible the establish ing of member companies in principal industrial centers thereby, it reports, enabling returning designers an engineers to establish themselves successfully in bus ness. This recently formed non-profit organizatio working with its member companies, will further ai in re-employment of returning servicemen by developin new products for manufacture and sale. Providin technical surveys, industrial research, merchandis engineering and new products services, the Foundatio will complement the services offered by member con panies of development engineering, industrial desig production engineering and tool engineering. Groups i terested in learning more about the program are invite to write Designers For Industry Research Foundatio 2915 Detroit Ave., Cleveland 13, Ohio.

Young Regulator Company, Cleveland, has moved it office from 4500 Euclid Ave. to 5209 Euclid Ave., Clev land 3, Ohio.

McCord Corporation, Detroit, announces the followin changes in executive organization: **P. L. Barter** has bee advanced to vice-president next to the president in th operation of the business; **W. G. Hancock** has bee elected vice-president in direct charge of operations **W. W. Harts, Jr.** has been elected treasurer, and **Jame H. Cooper** will be works manager in charge of all plant

U. S. Gauge Company, Sellersville, Pa., has relocate its Chicago office in the Monadnock Block, 53 Jackso Boulevard, Chicago 4, Ill. The office will be under th direction of **Walter H. Magee,** district sales manage who brings to his post a wide experience gained in h former association in the gauge industry as well a chief of pressure instruments, War Production Board.

Jones & Laughlin Steel Corporation, Pittsburgh, h purchased from Talon, Inc., that company's electr welded tube plant at Oil City, Pa. The plant has fac ities for producing electric welded mechanical and pre sure tubing in sizes ⅝-inch to 4-inch outside diamete inclusive. It products will supplement Jones & Laug lin's present line of seamless, lapwelded and buttweld tubular products. The new acquisition will be know as the Electric Weld Tube Division of Jones & Laughl Steel Corporation and will be operated with prese personnel.

Simplex Oil Heating Corp. announces the removal its office to 11 Park Place, New York 7, N. Y.

COMING EVENTS

JANUARY 8-12—Annual meeting and engineering display, Society of Automotive Engineers, Book-Cadillac Hotel, Detroit.

JANUARY 11-13—Louisiana Engineering Society. Annual meeting to be held at the St. Charles Hotel, New Orleans. Secretary, John K. Mayer, P. O. Station 20, New Orleans, La.

JANUARY 22-24—51st Annual meeting of the American Society of Heating and Ventilating Engineers, at Hotel Statler, Boston. Secretary, A. V. Hutchinson, American Society of Heating and Ventilating Engineers, 51 Madison Ave., New York.

JANUARY 22-26—Winter technical meeting of the American Institute of Electrical Engineers, 29 West 39th St., New York, N. Y.

JUNE 10-13—Summer convention of the American Society of Refrigerating Engineers to be held at the Hotel Schroeder, Milwaukee, Wis. Secretary David L. Fiske, 50 W. 40th St., New York 18, N. Y.

SEPTEMBER 17—Third Wartime Conference and 74th Annual meeting of American Public Health Association to be held at the Hotel Stevens, Chicago, Ill. Executive secretary, Reginald M. Atwater, M.D., American Public Health Association, 1790 Broadway, New York 19, N. Y.

WASHINGTON NEWS

(Continued from page 91)

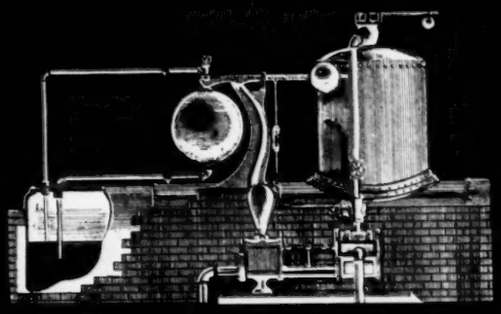
in spite of reaching a new production peak during 1944, the PAW anticipated that requirements will exceed production by from 10 to 16 million tons in the fuel year which ends March 31. Production for the calendar year 1944 is estimated at 621,000,000 tons. The previous all-time high, reached in 1943, was 589,000,000 tons.

As a first step in balancing supply and demand, the PAW announced that regulations governing distribution of bituminous coal mined in Indiana, Illinois and western Kentucky would be tightened on January 1 to make a larger share of the new mined output available for industrial consumers with small stocks, and for retail distribution.

The new regulations will compel consumers who built stocks up by summer storage to draw upon such stocks to provide 20 to 40% of their requirements. Industrial consumers having from 91 to 120 days' supply are prohibited from obtaining more than 80% of their requirements currently from the mines. Those having 120 days' supply are prohibited from obtaining more than 60% of their requirements from current production. In no instances is any consumer compelled to draw his stocks below 90 days. Those with 90 days or less coal in their stockpiles, and retail dealers, will be permitted to obtain their full current requirements directly from the mines.

(Concluded on page 116)

Advanced Design
1872



The Berryman Patent Regulator, assigned to Whitlock is acknowledged to be the most important device ever invented to promote safety and economy in the use of steam.

Advanced Design
1945
WHITLOCK
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Just as the Patent Regulator was the superior product in 1872, the present Whitlock Automatic Boiler Feed System features the substantial advances since that time. Today's Whitlock system continues to *fit the job*, offering many modern advantages in safety and efficiency—collecting condensation returns, adding necessary make-up supply and feeding the boiler to maintain exact water level at all times. The simplicity of the Whitlock Boiler Feed System makes installation easy and keeps maintenance low. Send for Bulletin 80 and complete information.

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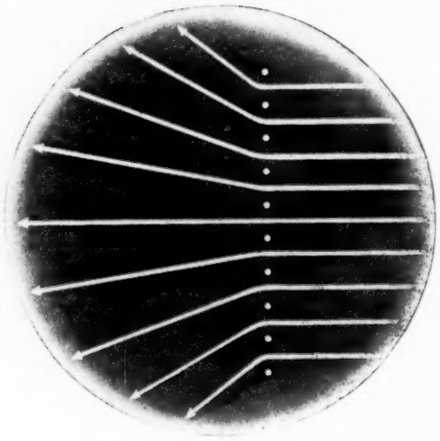

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You can direct the air flow in any pattern desired, with Waterloo Registers, because EACH blade is INDIVIDUALLY ADJUSTABLE. The throw of air can be lengthened for long rooms, broadened for wide rooms—and shifted both vertically and horizontally. After installation, corrections are quickly and easily made, to suit the individual needs of each room.

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Waterloo REGISTER CO.

Established 1902

Waterloo, Iowa **Seattle, Wash.**

Representatives in all principal cities

(Concluded from page 115)

Stoker Program Eyed

In line with the overall program to prevent add civilian production from interfering with essential w output, members of the Stoker Manufacturers Indust Advisory Committee were advised that authorizatio for the first quarter of 1945 under the regular progra would be subjected to a more critical review than w the case early in the fourth quarter, the War Producti Board announced today.

In spite of the fact that a number of producti authorizations have been granted, members of the co mittee said that only 50% of the stokers authorized a expected to be produced in the fourth quarter.

Factors involved in this inability to produce stoke were the shortage of motors and difficulties in procuri castings, committee members said.

Temporary, But—

All in all, the turn of the year finds Washingt chastened by happenings on the German front; not little chagrined at having guessed wrong, but neve theless determined to put first things first—this ti for as long as may be necessary.

INDUSTRIAL DEGREE DAYS
November, 1944

City	55F Base	45F B
Baltimore, Md.	235	4
Buffalo, N. Y.	418	18
Chicago, Ill.	348	13
Cleveland, Ohio	351	12
Detroit, Mich.	403	16
Indianapolis, Ind.	355	13
New York, N. Y.	292	7
Philadelphia, Pa.	253	5
Pittsburgh, Pa.	331	10
St. Louis, Mo.	301	9

Canadian Degree-Days for November, 1944*

City	November 1944	November Normal	Cumulative, Sept. 1 to Nov. 1944	Cumulative, Sept. 1 to Nov. Norma
Charlottetown, P. E. I.	750	858	1460	1619
Halifax, N. S.	681	789	1285	1486
Moncton, N. B.	822	936	1642	1813
St. John, N. B.	810	870	1556	1698
Quebec City, P. Q.	870	1050	1685	1977
Montreal, P. Q.	879	948	1635	1689
Ottawa, Ont.	900	984	1710	1783
Toronto, Ont.	756	821	1381	1496
London, Ont.	798	843	1489	1477
Windsor, Ont.	705	795	1123	1274
North Bay, Ont.	1005	1017	1981	1975
Porquis Junction, Ont.	1149	1266	2326	2462
Fort William, Ont.	966	1143	1954	2219
Winnipeg, Man.	1116	1302	2070	2376
Regina, Sask.	1278	1355	2176	2557
Saskatoon, Sask.	1320	1305	2186	2482
Medicine Hat.	1263	1104	1929	1972
Calgary, Alta.	1098	1122	1827	2276
Edmonton, Alta.	1251	1209	2194	2373
Grande Prairie, Alta.	1320	1218	2406	2510
Crescent Valley, B. C.	882	981	1657	2039
Penticton, B. C.	819	813	1428	1553
Prince George, B. C.	1011	1068	2076	2253
Vancouver, B. C.	588	657	1263	1350
Victoria, B. C.	549	462	1040	1172

*These data are supplied through the courtesy of the Meteorolo Division, Air Services Branch, Department of Transport, Canada, with cooperation of N. W. Etter, Heating Engineer, Enamel & Heating Pro Limited, Sackville, N. B.

ATMOSPHERIC POLLUTION

(Concluded from page 66)

assuming as low ceiling heights and wind velocities as may be expected to occur show that industrial exhaust system effluents will seldom cause objectionable air pollution over a widespread area. Assume that as many as 100 similar workrooms were to operate within a square mile area and each were to be ventilated of the same contaminant at the rate of 20,000 cfm of an effluent of 100 ppm contaminant concentration. Further assume as low as a 500 ft ceiling and only a one mile per hour wind. The resulting concentration of contaminant in the box over the area will be less than 0.1 ppm. Except in the case of extremely odorous contaminants, objectionable because of the unpleasantness of their odor, there are practically no gases or vapors likely to be discharged from the exhaust systems of factories which will be objectionable or hazardous in concentration as low as 0.1 ppm.

(To be concluded)

HEAT TRANSFER COEFFICIENT

(Concluded from page 90)

read $r_o = .00136$. The total resistance is therefore

$$R = r_i + r_p + r_o$$
$$= .00623 + .000601 + .00136 = .00819$$

and the rate of heat transfer is:

$$q = \frac{t_h - t_e}{R} = \frac{100 - 50}{.00819} = 6{,}110 \text{ Btu per hr per lineal foot.}$$

The length of pipe required is then 200,000/6110 = 32.7 ft.

The foregoing solution neglects change of temperature of either the water or ammonia during the heat exchange. If substantial temperature differences occur they would, of course, be needed for evaluation of the logarithmic mean temperature difference. It is interesting to note that for the conditions of the above example only (100 x .000601)/(.00819) = 7.3% of the total resistance is attributable to the pipe wall.

ARMY – NAVY

E

AWARDS

Kewanee Boiler Corporation
(Fourth award)

Aeroil Burner Co., Inc. (Plant No. 1),
West New York, N. J.

The Manhattan Rubber Mfg. Division of Raybestos-Manhattan, Inc., Passaic, N. J. (Third award)

Motoco *Indicating Thermometer Model F-1* $20.

Shown with capillary tubing for remote reading.

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